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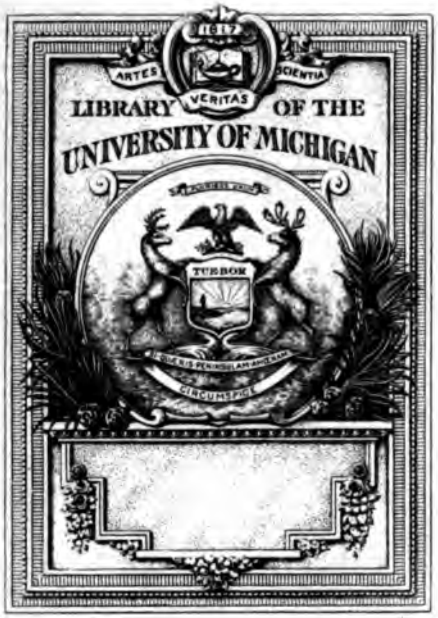

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42D CONGRESS, } HOUSE OF REPRESENTATIVES. { Ex. Doc. 1,
2d Session. } { Part 2.

REPORT

OF

THE SECRETARY OF WAR,

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE SECOND SESSION OF THE FORTY-SECOND CONGRESS.

VOLUME II.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1871.

REPORT

OF

THE CHIEF OF ENGIN

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5-9-37

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REPORT

OF

THE CHIEF OF ENGINEERS.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 20, 1871.

SIR: I have the honor to present, for your information, the following report upon the duties of the Engineer Department during the fiscal year ending June 30, 1871:

OFFICERS OF THE CORPS OF ENGINEERS.

The number of officers in the Corps of Engineers at the end of the fiscal year was 100 on the active list, and six on the retired list. In addition, the corps was aided in the performance of the duties intrusted to it, by a number of civil engineers, geologists, &c.

Since the last report, the corps has lost by death Major Chauncey B. Reese, brevet brigadier general United States Army; First Lieutenant William H. Chase and Brevet Second Lieutenant James B. Mackall, and one captain and two second lieutenants, by resignation; the captain, Brevet Lieutenant Colonel Peter S. Michie, having been appointed professor of natural and experimental philosophy at the Military Academy.

On the 30th of June, 1871, the officers were distributed as follows:

On duty in the office of the Chief of Engineers, including the Chief.	4
On duty with boards of engineers for fortifications	6
On duty with battalion of engineers	12
On duty, construction of fortifications	8
On duty, survey and construction of river and harbor improvements	23
On duty, construction of fortifications, and river and harbor improvements	21
On duty, survey of northern and northwestern lakes	6
On duty, explorations in the field west of Rocky Mountains	2
In charge of public buildings, grounds, &c	1
On special duty	1
Absent sick	1
Detached, on duty with generals commanding divisions, departments, &c., Light-House Establishment, Military Academy, &c.	15
Total	100

The officers detached were on duty as follows:

Lieutenant Colonel I. C. Woodruff, engineer third and fourth light-house districts	1

Major Nathaniel Michler, on staff of major general commanding Military Division of the Pacific	1
Major George H. Elliot, engineer secretary to Light-House Board	1
Captain John W. Barlow, on staff of Lieutenant General, commanding Military Division of the Missouri	1
Captain Peter C. Hains, engineer fifth and sixth light-house districts	1
Captain David P. Heap, on staff of commanding general Department of Dakota	1
Captain William A. Jones, on staff of commanding general Department of the Platte	1
First Lieutenant Ernest H. Ruffner, on staff of commanding general Department of the Missouri	1
Captain Garret J. Lydecker, First Lieutenant James C. Post, First Lieutenant James Mercur, First Lieutenant John C. Mallery, Second Lieutenant Albert H. Payson, Brevet Second Lieutenant Edgar W. Bass, and Brevet Second Lieutenant William L. Marshall, on duty at the Military Academy	7
	15

The following principal civil engineers and geologists were employed on the 30th of June: General J. H. Wilson, member of board of engineers upon improvement of the Des Moines and Rock Island rapids, and improvement of the Illinois River; Clarence King, geologist in charge of geological exploration of the fortieth parallel; and Professor Wesley Newcomb, mining engineer Sutro Tunnel Commission.

By legislation contained in section 6 of the act approved March 3, 1869, it is provided that there shall be no new appointments and no promotions in the Corps of Engineers until otherwise directed by law. Under the operations of this law, the strength of the Corps of Engineers has since that date become so much reduced, that the want of officers, for the performance of the varied and extensive duties imposed by law upon the Engineer Department, is becoming a serious embarrassment. It is earnestly recommended that Congress be asked to so modify the provisions of this law as to remove the prohibition of promotions and appointments in the corps.

SEA-COAST AND LAKE FRONTIER DEFENSES.

From the experience gained during the recent war in the attack and defense of sea-coast defenses, and from experiments made since the war, at home and abroad, upon materials in use in such defensive works, the conclusions have been arrived at which form the governing principles in determining the nature and extent of the sea-coast works we are now building. These conclusions, and the steps leading to them, have been set forth in my annual reports during the past few years, but the former may be briefly recapitulated as follows:

First. To confine the new constructions to powerful barbette batteries in earth and sand, thoroughly protected by traverses and parados, and to modify existing barbette batteries so as to bring them to the necessary standard of strength and efficiency;

Second. To substitute as far as practicable depressing gun carriages for those that expose the armament and cannoniers above the parapet;

Third. To make liberal use of heavy mortars;

Fourth. To employ torpedoes as accessories in the defense of the *channel ways and approaches* to the harbors;

Fifth. To use obstructions and floating batteries to retain the enemy before the guns of the littoral batteries; and

Sixth. To use in the batteries the most powerful guns of modern ordnance.

These principles for the construction of our coast defenses have received both executive and legislative approval, and moderate appropriations for constructions in accordance with them have been made by Congress for the defensive works of some of our principal sea ports and centers of commerce. With these appropriations good progress has been made, during the past year, in the modification of existing works and the commencement of new emplacements for heavy guns and mortars. For the works along the southern seaboard, the season of active operations, since the granting of appropriations for that section, has not yet arrived, but the modifications will be carried out as far as the moderate means available will allow during the coming working season.

Upon other fortifications not included in the above, the work has been confined principally to the protection of the sites, the preservation of those portions of the works in an unfinished condition, and to the modification of platforms for the introduction of heavier armaments.

In the preceding no reference has been made to casemated works, and there is at present no intention on the part of the Engineer Department to recommend either the modification of existing casemates or the construction of new works of this kind. But it is important that some guns at each of our great harbors should be protected by casemate cover of some kind. What that kind should be has not yet been satisfactorily determined. To learn what maritime countries were doing in this particular, and especially the extent to which iron had been introduced into their sea-coast defenses, Colonels Barnard and Wright and Captain Michie were, by your orders, sent abroad last year. The report of this Board of Engineers, now in press, contains the results of their observations and inquiries, so far as the information gained was not of a confidential character. This information will be found valuable in devising structures for the casemate cover of guns at those sites where such cover is essential to the perfection of the system of shore defenses.

Experiments have been made with King's counterpoise carriage, and are still in progress, while several designs of carriages for effecting the same purpose are under examination in the Engineer Department. There seems to be good reason to believe that a serviceable carriage for the purpose needed will soon be obtained, and in anticipation of this event the points at which such carriages should be placed in our projected works have been designated in advance.

Torpedo experiments, of the character mentioned in my report of the past year, have been carried on at Willet's Point, and considerable advance has been made in the investigation of the methods of firing torpedoes and the development of the law governing explosions of various powders under water.

The use of obstructions in the fairways and channels leading to our sea-ports will be indispensable in a conflict with a maritime power of any prominence, but neither these nor torpedoes can be successfully moored or managed without an intimate knowledge of the direction and velocities of the tidal currents peculiar to the localities. These considerations have led, during the past year, to a series of examinations in our principal harbors upon the velocity and direction of the currents, and data has thus been obtained not only useful for defensive purposes but also for commercial purposes in the improvement of the channel ways and harbors.

The progress made in each of the several works upon the coast is more particularly set forth in the following pages. The estimates of amounts required for the year have been made upon carefully considered projects, and are for the completion or continuance of the works in accordance with the approved principles already enunciated.

FORTIFICATIONS.

Fort Wayne, Detroit, Michigan, in charge of Major Walter McFarland until April 25, 1871; *since then of Captain G. L. Gillespie, Corps of Engineers.*—This work commands the channel of Detroit River, and, with its exterior barbette batteries, will control the navigation of that stream. These batteries are not completed, but should be finished and additional batteries projected. Plans for the modification of this work have been prepared during the past season, but are held for further consideration before being recommended for approval.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

No construction or repairs have been made during the past year. The expense incurred has been for the care and preservation of the work.

Fort Porter, Black Rock, near Buffalo, New York, in charge of Captain F. Harwood, Corps of Engineers.—This work occupies an important strategic point for the defense of the northern frontier. It remains in the condition reported in 1869–70, and no work has been done upon it during the past year. Projects for its repair have been prepared, but are withheld for further consideration.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Niagara, mouth of Niagara River, New York, in charge of Major N. Bowen from July 1 *to November* 23, 1870, *and from January* 13 *to* 25, 1871; *First Lieutenant B. D. Greene from November* 23, 1870, *to January* 13, 1871; *and Major John M. Wilson, Corps of Engineers, since January* 25, 1871.—This work is situated at the mouth of Niagara River, commanding its debouch into Lake Ontario. During the past year the force upon the work has been engaged as follows: Raising, grading, and sodding the terre plein and parapet of the north and south bastions and the curtain; building a wooden platform for a 4½-inch rifled gun, in rear of the flank casemate of the south bastion; removing imperfect brick and replacing them with new, and pointing the scarp wall; repairing and relaying the stone gutter, and making a new one down the slope at the south end of the main ditch.

No appropriation was made for fiscal year ending June 30, 1872; funds used were derived from appropriation for contingencies of fortifications.

Appropriation asked for the next fiscal year, $25,000.

During the present fiscal year it is proposed to repair the crib-work protection at the northwest angle of the fort, rebuild the six jettees along the lake shore, pave the postern, and make and hang the gates, build a slope-wall protection to the sea wall at the salient angle of the north bastion, pave the casemates, complete the drainage of the main ditch, and point and repair the scarp wall.

Fort Ontario, Oswego, New York, in charge of Major N. Bowen from July 1 *to November* 23, 1870, *and from January* 13 *to* 25, 1871; *First Lieutenant B. D. Greene from November* 23, 1870 *to January* 13, 1871; *and Major John M. Wilson, Corps of Engineers, since January* 25, 1871.—*This work protects* the city of Oswego from a sudden attack or *coup de* *main*, or the levy of a contribution by a small force of the enemy on shipboard. The work in progress upon the fort is the replacing of the old timber scarp, which has rotted away, by more durable materials, and the modification of the barbette for the heavy modern ordnance.

No appropriation was made for fiscal year ending June 30, 1872; funds used were derived from appropriation for contingencies of fortifications.

Appropriation asked for the next fiscal year, $30,000.

During the past year the force upon this work has been employed as follows: Continuing gallery in right flank of bastion E, completing it, except coping and lintel to entrance; completing scarp wall of right face of bastion E, and curtain A–E, and backing it with concrete; continuing gallery in left flank of bastion A; completing scarp wall of curtain A–B, except coping, and nearly completing scarp wall of the left face of bastion B; building dry walls in the galleries and under the back of stairways in bastions E and A; sodding parapets of right and left faces, and grading terre plein of bastion D; putting new roofs on guard-houses, and introducing city water and placing fire-hydrant in the vicinity of the engineer store-houses.

During the present year it is proposed to complete the gallery in bastion E, and the one in the left flank of bastion A; to put on the coping and parapet around to the salient of the latter bastion; to build the connection of the gallery in bastion D, with the proposed magazine, and complete the parapet as far as the right re-entering angle of bastion C.

Fort Montgomery, outlet of Lake Champlain, New York, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—This work occupies an important strategic point, and commands the entrance to Lake Champlain from Richelieu or St. John River. The work is essentially completed for the old styles of armament, and requires modifications to suit it to the modern guns. Projects for this purpose have been prepared by the Board of Engineers for fortifications, and approved, and the necessary modifications directed to be made.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, needed to complete this work, $22,000.

Fort Knox, Bucksport, Penobscot River, Maine, in charge of Lieutenant Colonel J. C. Duane, Corps of Engineers.—This work, situated at the narrows of the Penobscot River, furnishes a defense for the city of Bangor and other towns bordering the Penobscot, and renders the river available as a secure harbor of refuge for the shipping of the extensive eastern sea coast. The work is essentially completed, with the exception of some modifications in its barbette batteries to fit them for the large guns now used.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

The condition of this work remains the same as at the close of the last fiscal year, the only work performed being such as was necessary for the repairs of temporary roofs and general care of the work.

Fort Popham, mouth of Kennebec River, Maine, in charge of Lieutenant Colonel J. C. Duane, Corps of Engineers.—This work defends the entrance, through the mouth of Kennebec River, to the rich valley of this river, the cities of Bath and Augusta, and the United States arsenal at the latter place. It has been finished upon its gun-fronts to the level of the barbette batteries. The projects for it completion have not yet been prepared.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Gorges, Portland Harbor, Maine, in charge of Lieutenant Colonel J. C. Duane, Corps of Engineers.—This work is one of the series of forts designed to defend the harbor and channels leading into the harbor of the important strategic position occupied by the city of Portland.

Amount appropriated for fiscal year ending June 30, 1872, $15,000.

Appropriation asked for next fiscal year, $20,000.

After an interruption of more than a year, work on this fort was resumed on August 8, 1870, and during the past year the great magazine on Front I, with the exception of its interior wood work, the central traverse magazine, and the new entrance to the easterly traverse magazine, and the breast height walls of Front VI, were completed. The earth work of Front VI was nearly finished, excepting the grading and sodding of the slopes. It is expected that this work upon both Fronts VI and I will be completed before the close of the coming fiscal year, so that all the barbette guns of this fort can be mounted.

New Fort Preble, Portland Harbor, Maine, in charge of Lieutenant Colonel J. C. Duane, Corps of Engineers.—The work of carrying out the present plans for the completion of this fort was commenced on August 10, 1870. Since that date, the traverse magazine and earth work, in the gap between the north battery and old redoubt, has been finished, except the sodding of slopes. One of the two traverse magazines and about one-half of the great magazine in the old redoubt, have been built, and a considerable quantity of earth hauled in for embankments. One new traverse magazine in the south battery extension has been finished, except grading and sodding, and the necessary excavation for about 400 feet of the battery has been one-third completed.

During the present year it is expected that the work in and adjoining the old redoubt will be essentially completed; that the parapet for the first four bays of the extension of south battery and four new traverses will be constructed, and that nine new positions will be ready for guns.

Amount appropriated for fiscal year ending June 30, 1872, $28,500.

Appropriations asked for the next fiscal year, $50,000.

Fort Scammell, Portland Harbor, Maine, in charge of Lieutenant Colonel J. C. Duane, Corps of Engineers.—This work occupies a very important position in the harbor, and commands four of the channels leading into it. No work of construction was carried on upon this fort from November, 1868, till August 22, 1870. Since the latter date the old block house, most of the old buildings in the parade, and the two small service magazines in the circular bastion were demolished, to make way for the new work. The parapet of the circular bastion was partially re-enforced by an exterior embankment. Rock excavation for the foundation of the great magazine in the old work is nearly finished. All the traverse magazines, six in number, in the old work, were built and covered with from two to five feet of earth; but their proper connections with the parados remain to be made after the construction of the latter.

During the present year the great magazine, most of the parados, and the new arches in the west bastion will be built.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $100,000.

New work at Portland Head, Portland Harbor, Maine.—An approved project has been for some time past prepared for the occupation of this position by a barbette battery for thirty-four guns of heaviest caliber, so arranged that all the approaches to the main channel leading into the arbor will be swept by some or all of its guns, and an enemy's fleet will be prevented by its fire from taking up unopposed a position behind Bangs Island, from which to bombard Portland or shell the shipping in the harbor. It is important to the safety of the city and harbor that works of defense exterior to the existing forts shall be provided, and an appropriation for the commencement next year of this battery is urged.

No appropriation has been made as yet for this work.

Appropriation asked for next fiscal year, $62,000.

Fort McClary, Portsmouth Harbor, Kittery Point, Maine, in charge of Lieutenant Colonel J. G. Foster until May 6, 1871; *since then Lieutenant Colonel J. C. Duane, Corps of Engineers.*—This work, together with Fort Constitution, opposite, forms the only defense to the mouth of the Piscataqua River and to the navy-yard at Kittery, Maine. The plans for this work were made and approved in 1866; and so far as the erection of the several portions do not conflict with the system as lately adopted for our defenses, it is proposed to continue the construction.

No appropriation was made for the fiscal year ending June 30, 1872.

Appropriation asked for the next fiscal year, $75,000.

The condition of this fort remains the same as at the close of the last fiscal year, no operations having been carried on during the past year excepting the necessary care of the work.

New Fort Constitution, Portsmouth Harbor, New Hampshire, in charge of Lieutenant Colonel J. G. Foster, until May 6, 1871; *since then Lieutenant Colonel J. C. Duane, Corps of Engineers.*—This is a casemated work, and the Engineer Department is not prepared, at present, to proceed with its construction.

The condition of this fort remains the same as at the close of the last fiscal year, no operations having been carried on during the past year excepting the necessary care of the work.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Warren, Boston Harbor, Massachusetts, in charge of Colonel H. W. Benham, Corps of Engineers.—This important work is for the defense of the main channel of entrance to Boston Harbor, and command of the anchorage of Nantasket Roads. The modifications embraced in the recently approved plans are well under way, and should be pushed to completion at an early day.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $150,000.

The work executed here has been mainly upon the demilune south of the main work, in preparing it for enlarged ordnance in the upper battery. The concrete masonry of the two traverse magazines proposed has been constructed, and the earth embankments partly laid. On the main work, in bastion, (A,) the parade walls have been mostly taken down, and the drains of the interior space have been rebuilt. The foundations of all the piers for the new large arches for covering this space have been completed, while a large supply of bricks, concrete material, sand, &c., has been collected for a vigorous prosecution of the work in the present year.

With the appropriations made in 1870 and 1871 for this work, it is contemplated during the present year to complete the modifications of the demilune, including its parados and magazine traverses, the modification of bastion A of the main work, with the barbette battery upon the terre plein, the barbette battery upon the coverface, and some of the positions for heavy guns in bastion E.

Battery at Long Island Head, Boston Harbor, Massachusetts, in charge of Colonel H. W. Benham, Corps of Engineers.—This important work is especially intended to command the entrance into Boston Harbor through Broad Sound, and its early completion is desirable.

Amount appropriated for fiscal year ending June 30, 1872, $37,500.

Appropriation asked for the next fiscal year, $75,000.

During the past fiscal year the necessary buildings, store and boarding houses, were arranged for, and partly built, by the close of the year. Arrangements for a wharf have been made since that date, and the structure, now partly built, with the necessary roadway to the hill, it is expected, will soon be completed. The magazines, bomb-proof arches, &c., with their earth coverings, and the necessary embankments for the battery, will be pushed forward during the present year as far as possible with the means on hand.

Fort Winthrop, Boston Harbor, Massachusetts, in charge of Colonel H. W. Benham, Corps of Engineers.—In this work the modifications stated in previous reports are being carried out, and some of the batteries are approaching the condition required for the service of the larger calibers of guns.

Amount appropriated for fiscal year ending June 30, 1872, $45,500.

Appropriation asked for next fiscal year, $75,000.

During the year the battery planned for the covered way of the tower was laid out and brought up to the level of the terre plein throughout, and, in some parts, above that level. In the south battery and east battery necessary preparations have been made for the modifications proposed for the new armament. And on the east battery the concrete masonry, mainly complete, with the doorways of five of the six traverse magazines, has been constructed; also the breast height wall of the left face and the foundation of the breast height of the right face, while the lower part of the earth embankment of the traverse has been put in position, and the drainage system enlarged and re-arranged. On the south battery there has been constructed the masonry with the doorway complete of three of the traverse magazines on the part next west of the present 15-inch gun battery, and the drainage of this part has been improved and enlarged. On the tower a wooden roof has been placed, and the parade has been re-covered with asphalt, and such other repairs added to earth slopes, masonry, &c., as appeared to be necessary.

With the appropriations made in 1870 and 1871 for this work, it is contemplated during the present year to complete the modifications of the east battery and more than one-half of the south battery, with all the necessary magazines and traverses and the emplacements for the heavy guns designated for those positions.

Fort Independence, Boston Harbor, Massachusetts, in charge of Colonel H. W. Benham, Corps of Engineers.—This work, with Fort Winthrop on the opposite side of the main ship channel, constitutes the inner line of defense for the harbor of Boston. The modification of the works consists of a re-arrangement of its barbette batteries, in accordance with the approved plans of the Board of Engineers.

Amount appropriated for fiscal year ending June 30, 1872, $27,500.

Appropriation asked for next fiscal year, $50,000.

During the fiscal year the quarters for a working force have been rebuilt or repaired. The masonry of two new traverse magazines near the gorge of the east bastion has been constructed, and that of a third magazine upon the east curtain completed, and a quantity of sand, concrete material, and curbstone magazine doorways prepared for future use.

With the appropriations made for this work in 1870 and 1871, it is proposed during the present year to complete the modifications of the barbette of the main work, involving the thickening of the parapets, construction of new breast height walls, and the necessary magazines and traverses and gun platforms for the heavy ordnance designed for this position.

Fort at Clark's Point, New Bedford Harbor, Massachusetts, in charge of Major G. K. Warren, Corps of Engineers.—This is a casemated work which has been completed, with the exception of its barbette battery over the casemates. The Board of Engineers has recommended that at present nothing further should be done to it other than to preserve it from deterioration, and that an earthen barbette battery for twenty-six 15-inch smooth bore or equivalent rifled guns be erected on the hill in rear of the fort.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $40,000.

No work has been done at this place during the past fiscal year.

Fort Phœnix, New Bedford Harbor, Massachusetts, in charge of Major G. K. Warren, Corps of Engineers.—No work has been done on this fort during the past fiscal year, none is now contemplated, and no appropriation is asked for.

No appropriation was made for fiscal year ending June 30, 1872.

Fort Adams, Newport Harbor, Rhode Island, in charge of Major G. K. Warren, Corps of Engineers.—The project of the Board of Engineers for this work has been approved, and the modifications proposed are confined almost exclusively to the exterior barbette batteries. The work upon those should be commenced at as early a day as practicable, and appropriations for that purpose are now asked. Funds are also asked for commencing the permanent quarters for officers at this post, the construction of which has been long delayed for want of necessary appropriations.

No appropriation was made for fiscal year ending June 30, 1872.

Amount asked for next fiscal year, to be applied to the exterior batteries and quarters, $100,000.

The work on this fort during the past year has consisted mainly as follows: Repairing temporary wharf on east front; filling and grading cellar of old permanent quarters, southeast glacis; removing brick therefrom; repairing rotten door frames in casemates of southeast interior front; refacing embrasures on west and north fronts with cement; repairing roads; altering redoubt in place-of-arms, east front, to better adapt it to its use as a post guard-house; refilling valleys of arches on terre plein of west front, they having been opened some time since to repair leaks; constructing roads and sea wall; connecting the temporary wharf on the east front and the permanent wharf on the north front, as well as repairing the former wharf and dredging about it, to give more vessel room; necessary repairs of officers' casemate quarters east front; general care of public property.

Dumpling's Battery, Canonicut Island, Rhode Island.—On the site of the old Dumpling's Tower, where the Government owns about five acres of land, it is proposed to construct a barbette battery for ten 15-inch, smooth bore, or equivalent rifle guns, with magazine traverses between each pair. This battery will effectively cross its fire with the guns of Fort Adams.

The estimated cost of this battery, owing to the heavy rock excavation, is $100,000.

No appropriation has as yet been made for this battery.

Appropriation asked for next fiscal year, $50,000.

Defenses of Dutch Island, western entrance to Narragansett Bay, Rhode

Island, in charge of Major G. K. Warren, Corps of Engineers.—These defenses are to consist of three detached barbette batteries, situated upon the summit of the island, and affording emplacements for forty 15-inch guns, or equivalent rifles.

Amount reappropriated for fiscal year ending June 30, 1872, $121,998.

Appropriation asked for next fiscal year, $50,000.

The work here during the year consisted mainly in preparations for commencing the batteries under the recent reappropriation; purchasing, receiving, and storing various materials; altering, repairing, building, and moving buildings, old and new; completing pavement of permanent wharf; repairing temporary wharf and vehicles and implements; repairing roads; building shot beds in upper barbette battery for 15-inch projectiles; digging down to the underlying rock of the island, for the purpose of obtaining information concerning the material to be met with, and the best means to adopt in constructing the new batteries, together with the usual work incident to the care of public property.

Fort Trumbull, New London Harbor, Connecticut, in charge of Major G. K. Warren,. Corps of Engineers.—This work, upon the west bank of the Thames River, with Battery Griswold on the east bank, forms the defense of the harbor of New London. Plans have been approved for the modification of the exterior barbette batteries, to mount twelve 15-inch guns, or equivalent rifles.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $20,000.

No work has been done at this fort during the past fiscal year.

Fort Griswold, New London Harbor, Connecticut, in charge of Major G. K. Warren, Corps of Engineers.—Plans for the modification of this barbette battery have been prepared in accordance with the system adopted for our sea-coast works of this description.

It is proposed to arrange the work for nine 15-inch guns.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $20,000.

No work has been done at this fort during the past fiscal year.

Fort Hale, New Haven Harbor, Connecticut, in charge of Major G. K. Warren, Corps of Engineers.—During the past fiscal year but little work has been done at this fort. Negotiations have been and still are pending concerning the purchase of required additions to this site. This fort was built for temporary defense during the late war, and its object having been accomplished, it has been dismantled. Several of the buildings appertaining, and which had been somewhat injured during a heavy storm, were taken down and transferred to the public works at Dutch Island, Rhode Island.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Fort Schuyler, East River, New York, in charge of Major H. L. Abbot, Corps of Engineers.—The reports of former years set forth the modifications proposed on this important work for the defense of New York City from approach through East River. In brief, these modifications consist of the alterations necessary to adapt the batteries for the service of the heavy ordnance.

Amount appropriated for fiscal year ending June 30, 1872, $57,500.

Appropriation asked for next fiscal year, $100,000.

On the main work the modifications of the north front, to prepare the barbette tier to receive a modern armament, have progressed as far as the turning of the arches, except the raising of the bastion pier. The ooden bridge for the supply of materials across the ditches is about half completed. On the cover face, emplacements for four heavy guns have been essentially completed, and the parados on the south bastion has been begun. In the place-of-arms the parados covering two magazines and a large bomb proof has been essentially completed; two traverses have been built, and the requisite thickening of the parapet has been finished. The new battery for three modern guns at the north end of the covered way is essentially completed with the magazine. Necessary repairs have been made upon the sea-wall, temporary buildings, &c.

Fort at Willet's Point, eastern entrance to New York Harbor, in charge of Major H. L. Abbot, Corps of Engineers.—This work unites with Fort Schuyler in the defense of the entrance to the harbor of New York City through the East River, and its site is favorable to the construction of earthen barbette batteries. The operations for the removal of natural obstructions to navigation at Hell Gate, render it even more important than heretofore that this channel of approach to New York City and the Brooklyn navy-yard should be put in a proper state of defense.

Amount appropriated for fiscal year ending June 30, 1872, $45,000.

Appropriation asked for next fiscal year, $90,000.

During the past year an underground passage from the new bluff batteries to the water battery, 270 feet long, has been completed; about three-quarters of the large storage magazine, designed to contain 250,000 pounds of powder, has been finished; six service magazines have been nearly finished and the foundations for another laid; the parapet, covering emplacements for twelve heavy guns, has been so far completed as to be ready for the guns if necessary.

Fort Columbus, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—In the new barbette battery eight traverse magazines have been built, the parapet has been partially constructed the whole length of the battery, excavations have been made for the terre plein, for road in rear of terre plein, and for foundations for the remaining eight magazines.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $70,000.

Castle William, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—Nothing has been done at this work during the past year.

South Battery, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—Nothing has been done at this work during the past year.

Fort Wood, Bedloe's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—This work, together with those upon Governor's Island, is designed to close the entrance to the East and Hudson rivers and to cover New York, part of Brooklyn, and Jersey City, from the bombardment of a hostile fleet in New York Bay.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $17,000.

In the new water battery, five traverse magazines have been built; the parapet has been constructed the whole length of the battery; the terre plein has been raised to the proper height.

Fort Hamilton, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—This work is situated at the Narrows of New York Harbor, upon the Long Island side. Until the question as to the use of iron to cover guns can be determined, no work is proposed upon it other than that necessary for its preservation. At present it is best devoted to the purposes of a keep for the detached earthen barbette batteries around it, for quarters and store-houses, and for the reception of mortars on its terre pleins. The work during the past year has been confined to repairs, and the alteration of some embrasures in the officers' quarters.

Fort Hamilton and additional batteries, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—These batteries are earthen barbette batteries exterior to Fort Hamilton, and constitute powerful auxiliaries to the defense of the Narrows.

Amount appropriated for fiscal year ending June 30, 1872, $25,000.

Appropriation asked for next fiscal year, $40,000.

Operations were commenced on water battery No. 1, by building a coffer dam 484 feet long and 83 feet from the shore line; the foundation was commenced by driving piles and spiking timbers to them, forming a grillage bottom, which was leveled off with rubble stone and concrete. The sea wall was carried up five courses, (ref. 6 feet 9 inches.)

Fort Wadsworth, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—This fort is situated on the Staten Island side of the Narrows of New York Harbor, and is a large casemated work. No modifications are proposed at present in it, and no funds asked other than for its preservation. During the past year operations were confined to the repairs of the long earthen slopes in the rear of the work.

Fort on site of Fort Tompkins, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—This work crowns the hill in rear of the open batteries and other works on Staten Island, defending the entrance through the Narrows to New York Harbor, acts as a keep for those works, and when completed, will throw a heavy fire from a high elevation upon vessels attempting to pass before it.

Amount appropriated for fiscal year ending June 30, 1872, $52,000.

Appropriation asked for next fiscal year, $32,000.

The operations have been mostly confined to the construction of the bomb proofs of the channel front and the excavation of the earth from the parade, depositing the same to fill in the large slope and cover face in front of the fort.

The piers and arches of the seventeen bomb proofs between the two sally ports, including the foundations of the casemate extensions, have been constructed. The scarp wall between the sally ports was finished, with the exception of an opening left in the center for temporary egress and ingress. The piers and skew backs of both the sally port arches have been built. The parade wall was carried two feet above the top of parade arches, and the concrete forming the roof surfaces of the casemate arches was nearly made ready for the mastic covering. The brick sewer running under the center of the channel front has been connected near the northwest gorge flank of Fort Wadsworth with the sewer running from the south soldiers' latrine.

The connection was made with cement pipe measuring 2 feet interior diameter and 381 feet in length.

The cisterns under the casemates of the channel front have been connected with each other by suitable pipe and made ready to receive the drainage from the casemate roofs. The portion of earth filling to form the cover face in front of the scarp has been connected with the casemate roof surface by a temporary wooden bridge, so that the earth filling over the arches can be transported and deposited without being twice handled. The iron balcony for the parade of the channel front is in readiness to be put up.

During the current fiscal year it is contemplated to complete the channel front of Fort Tompkins, and put it in readiness for its battery, according to the existing plan, (omitting the completion of the cover face and the construction of the parade and division walls of the casemate,) to place the iron balcony around the entire parade of the work, to excavate the parade to its proper grade, and to put up the gates and side loop-holed walls in the two sally ports.

Glacis Mortar Battery, (south of Fort Tompkins,) in charge of Major Q. A. Gillmore, Corps of Engineers.—During the past fiscal year the earth work and sodding of this battery were completed, except a portion of the rear slope and the covering of the principal magazine, of which one-fourth of the concrete masonry is already laid.

The two service magazines were also finished, except the doors and granite coping to be laid on the entrance retaining walls. The battery will be finished and ready for the platforms and armament during the present working season.

No appropriation asked for next fiscal year.

Battery Hudson, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—This work, together with those on the north and south cliffs, forms a system of open earthen barbette batteries, lying exterior to Forts Tompkins and Wadsworth, and brings a powerful fire to bear upon the channel, up to and through the Narrows.

Amount appropriated for fiscal year ending June 30, 1872, $16,000.

Appropriations asked for next fiscal year, $17,000.

That portion of the battery near the light-house and west of the 15-inch center pintle platform has been cleared to give room for platforms for 15-inch guns and two service magazines. The latter have been built during the year and are complete except the doors and a portion of the earth work and sodding and the coping of the wing walls. In the extension of the battery the masonry of the two service magazines and the principal magazine is complete, except the coping wing walls. The earth excavations to form the rear slopes, and the filling over the magazines, are all in a forward state and nearly ready for sodding. It is expected that the Battery Hudson extension, and the return at the light-house, will be completed and made ready for their new armaments during the present working season.

North Cliff Battery, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations were carried on during the past fiscal year, except to clear the earth from the terreplein, where it had been washed from the unfinished slope at the north end of the battery. The earth was deposited to form the parapet. This battery may be finished according to existing plans during the present fiscal year.

South Cliff Battery, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations were carried on during the past fiscal year, except to cut the grass and keep the gutters and cesspools open. The battery may be finished according to the existing plans during the present fiscal year.

Fort at Sandy Hook, New Jersey, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—The condition of this work remains the same as at the date of the last annual report, the watchmen being the only force employed during the year.

Operations were commenced in the latter part of the month of June, 1871, for constructing additional jettees for protecting the site of the fort, $13,500 having been allotted from appropriation for contingencies of fortifications.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Mifflin, Delaware River, Pennsylvania, in charge of Lieutenant Colonel J. D. Kurtz, Corps of Engineers.—This fort constitutes one of the inner line of works for the defense of Philadelphia and the naval establishment at League Island.

Amount appropriated for fiscal year ending June 30, 1872, $26,000.

Appropriation asked for next fiscal year, $85,000.

During the last year two small service magazines in the demilune have been commenced and continued to completion.

There have also been executed repairs and restoration of the dikes near the fort; excavation and clearing of the ditches; re-adjusting the surfaces of the 15-inch gun platforms; cleansing and purifying the quarters, barracks, and store-houses; repairs of roads and bridges; construction of a new sluice for the use of the ditches of the work; attention to grassed surfaces, and minor repairs to scarp, parapet, and buildings.

The present year it is proposed to complete the two demilune traverses and the three gun platforms of its south face, to construct two traverses and magazines of the exterior battery, with five corresponding gun platforms, the storage magazine in demilune, and half of the mortar battery below the fort.

Next year it is proposed to construct the new breast height wall, two 15-inch gun platforms, and one earth traverse in demilune; one traverse with magazine, four 15-inch gun platforms, and the sand and earth embankment of the exterior battery; also to complete mortar battery, for six mortars south of the fort.

Fort Delaware, Delaware River, Delaware, in charge of Lieutenant Colonel J. D. Kurtz, Corps of Engineers.—This work, situated on the Pea-Patch Island, forms one of the chain of works constituting the outer line of defense for the Delaware River.

No appropriation was made for the fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $50,000.

Operations were commenced on the 12th September, 1870, to make provision for new platforms for large guns, with their magazines and traverses. Six of these magazines have been constructed of concrete masonry, and the embankment of the traverses has been commenced.

The levee on the southern and southwestern sides of the island has been rebuilt for a distance of 2,450 feet; the stone revetment on the sea face has been relaid and the main ditch, inside the bank, thoroughly cleaned out for more than that distance.

During the present year the work on the barbette platforms, with their magazines and traverses, will be completed. Next year it is proposed to cleanse the remaining ditches and repair the banks on the upper faces of the island; to complete the coping of dock walls; build the stone facing to the upper eastern wharf; remove upper stories of the quarters on parade of fort; repair the scarp on Front I, and execute minor repairs of bridges, walls, roads, and walks, breast heights, and counterscarp walls, parade, and stair towers.

Battery at Finn's Point, Delaware River, New Jersey, in charge of Lieutenant Colonel J. D. Kurtz, Corps of Engineers.—The construction of this powerful earthen barbette battery for this point, to form the left of the outer line of defenses across the mouth of the Delaware River, has been delayed for want of the necessary act of cession of jurisdiction of the site from the state of New Jersey. This act will be obtained the coming winter, and operations pushed forward the coming season.

Amount appropriated for fiscal year ending June 30, 1872, $20,000.

No appropriation asked for next fiscal year.

New Fort, opposite Fort Delaware, Delaware shore, in charge of Lieuten-

ant Colonel J. D. Kurtz, Corps of Engineers.—Measures have been taken for the acquisition of the site of this barbette battery, and it is expected that active operations will commence in a short time.

It is proposed, during the present fiscal year, to build a wharf and the necessary temporary buildings, and to commence the construction of the battery.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $50,000.

Fort McHenry, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work forms part of the inner line of defense for Baltimore and its dependent interests, and commands with its fire the interior waters of its harbor and the channels of approach thereto. A project for a large exterior battery for guns of the largest calibers has been prepared, and an appropriation is asked for its commencement.

No appropriation was made for the fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $25,000.

The wharf, which was much decayed by long use, has been rebuilt. The floor of the large magazine exterior to the work has been renewed. The armament of the work has remained unchanged.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a view to selecting the best location for explosive and other obstructions to the passage of hostile vessels.

Lazaretto Point, opposite Fort McHenry, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work will cross its fire with that from Fort McHenry, constituting one of the inner line of defenses of the harbor, and consists of an earthen barbette battery for the largest guns. The site selected is now the property of the United States, and an appropriation is asked for the commencement of the work.

No appropriation has as yet been made for this work.

Appropriation asked for next fiscal year, $15,000.

Fort Carroll, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work is situated upon the outer line for the defense of the harbor of Baltimore. It is a casemated work, and until the methods of arranging such works shall have been devised, no expenditure is proposed upon it other than for preservation.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a view to selecting the best location for explosive and other obstructions to the passage of hostile vessels.

Obstructions of the Potomac, in charge of Major Wm. P. Craighill, Corps of Engineers.—It has not yet been found practicable to make the desired experiments upon these obstructions. The material has been kept in store at Fort Foote.

Fort Foote, Potomac River, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work forms the inner line of defense of the channel of approach by water to Alexandria and the cities of Washington and Georgetown. The projects for the modification of this work and erection of an additional battery of the heaviest guns have been submitted. Arrangements have been made for the purchase of the site. The wharf has been rebuilt.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a

Island, in charge of Major G. K. Warren, Corps of Engineers.—Thes defenses are to consist of three detached barbette batteries, situate upon the summit of the island, and affording emplacements for fort 15-inch guns, or equivalent rifles.

Amount reappropriated for fiscal year ending June 30, 1872, $121,99

Appropriation asked for next fiscal year, $50,000.

The work here during the year consisted mainly in preparations fo commencing the batteries under the recent reappropriation; purchasing receiving, and storing various materials; altering, repairing, building and moving buildings, old and new; completing pavement of permanen wharf; repairing temporary wharf and vehicles and implements; repairing roads; building shot beds in upper barbette battery for 15-inch projectiles; digging down to the underlying rock of the island, for the purpose of obtaining information concerning the material to be met with and the best means to adopt in constructing the new batteries, togethe with the usual work incident to the care of public property.

Fort Trumbull, New London Harbor, Connecticut, in charge of Major G K. Warren, Corps of Engineers.—This work, upon the west bank of the Thames River, with Battery Griswold on the east bank, forms the defense of the harbor of New London. Plans have been approved for the modification of the exterior barbette batteries, to mount twelve 15-inch guns, or equivalent rifles.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $20,000.

No work has been done at this fort during the past fiscal year.

Fort Griswold, New London Harbor, Connecticut, in charge of Major G. K. Warren, Corps of Engineers.—Plans for the modification of this barbette battery have been prepared in accordance with the system adopted for our sea-coast works of this description.

It is proposed to arrange the work for nine 15-inch guns.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $20,000.

No work has been done at this fort during the past fiscal year.

Fort Hale, New Haven Harbor, Connecticut, in charge of Major G. K. Warren, Corps of Engineers.—During the past fiscal year but little work has been done at this fort. Negotiations have been and still are pending concerning the purchase of required additions to this site. This fort was built for temporary defense during the late war, and its object having been accomplished, it has been dismantled. Several of the buildings appertaining, and which had been somewhat injured during a heavy storm, were taken down and transferred to the public works at Dutch Island, Rhode Island.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Fort Schuyler, East River, New York, in charge of Major H. L. Abbot, Corps of Engineers.—The reports of former years set forth the modifications proposed on this important work for the defense of New York City from approach through East River. In brief, these modifications consist of the alterations necessary to adapt the batteries for the service of the heavy ordnance.

Amount appropriated for fiscal year ending June 30, 1872, $57,500.

Appropriation asked for next fiscal year, $100,000.

On the main work the modifications of the north front, to prepare the barbette tier to receive a modern armament, have progressed as far as the turning of the arches, except the raising of the bastion pier. The wooden bridge for the supply of materials across the ditches is about half completed. On the cover face, emplacements for four heavy guns have been essentially completed, and the parados on the south bastion has been begun. In the place-of-arms the parados covering two magazines and a large bomb proof has been essentially completed; two traverses have been built, and the requisite thickening of the parapet has been finished. The new battery for three modern guns at the north end of the covered way is essentially completed with the magazine. Necessary repairs have been made upon the sea-wall, temporary buildings, &c.

Fort at Willet's Point, eastern entrance to New York Harbor, in charge of Major H. L. Abbot, Corps of Engineers.—This work unites with Fort Schuyler in the defense of the entrance to the harbor of New York City through the East River, and its site is favorable to the construction of earthen barbette batteries. The operations for the removal of natural obstructions to navigation at Hell Gate, render it even more important than heretofore that this channel of approach to New York City and the Brooklyn navy-yard should be put in a proper state of defense.

Amount appropriated for fiscal year ending June 30, 1872, $45,000.

Appropriation asked for next fiscal year, $90,000.

During the past year an underground passage from the new bluff batteries to the water battery, 270 feet long, has been completed; about three-quarters of the large storage magazine, designed to contain 250,000 pounds of powder, has been finished; six service magazines have been nearly finished and the foundations for another laid; the parapet, covering emplacements for twelve heavy guns, has been so far completed as to be ready for the guns if necessary.

Fort Columbus, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—In the new barbette battery eight traverse magazines have been built, the parapet has been partially constructed the whole length of the battery, excavations have been made for the terre plein, for road in rear of terre plein, and for foundations for the remaining eight magazines.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $70,000.

Castle William, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—Nothing has been done at this work during the past year.

South Battery, Governor's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—Nothing has been done at this work during the past year.

Fort Wood, Bedloe's Island, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—This work, together with those upon Governor's Island, is designed to close the entrance to the East and Hudson rivers and to cover New York, part of Brooklyn, and Jersey City, from the bombardment of a hostile fleet in New York Bay.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $17,000.

In the new water battery, five traverse magazines have been built; the parapet has been constructed the whole length of the battery; the terre plein has been raised to the proper height.

Fort Hamilton, New York Harbor, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—This work is situated at the Narrows of New York Harbor, upon the Long Island side. Until the question as to the use of iron to cover guns can be determined, no work is proposed upon it other than that necessary for its preservation. At present it is best devoted to the purposes of a keep for the detached earthen barɔette batteries around it, for quarters and store-houses, and :eception of mortars on its terre pleins. The work during the pı ıas been confined to repairs, and the alteration of some embra :he officers' quarters.

Fort Hamilton and additional batteries, New York Harbor, in ɔf Lieutenant Colonel John Newton, Corps of Engineers.—The :eries are earthen barbette batteries exterior to Fort Hamilt :onstitute powerful auxiliaries to the defense of the Narrows.

Amount appropriated for fiscal year ending June 30, 1872, $25

Appropriation asked for next fiscal year, $40,000.

Operations were commenced on water battery No. 1, by buil :offer dam 484 feet long and 83 feet from the shore line; the foun was commenced by driving piles and spiking timbers to them, fo ı grillage bottom, which was leveled off with rubble stone an :rete. The sea wall was carried up five courses, (ref. 6 feet 9 incl

Fort Wadsworth, New York Harbor, in charge of Major Q. A. Gil Corps of Engineers.—This fort is situated on the Staten Island ı :he Narrows of New York Harbor, and is a large casemated work nodifications are proposed at present in it, and no funds asked :han for its preservation. During the past year operations wer ined to the repairs of the long earthen slopes in the rear of the

Fort on site of Fort Tompkins, New York Harbor, in charge of Q. A. Gillmore, Corps of Engineers.—This work crowns the hill i ɔf the open batteries and other works on Staten Island, defendin :ntrance through the Narrows to New York Harbor, acts as a ke :hose works, and when completed, will throw a heavy fire from a :levation upon vessels attempting to pass before it.

Amount appropriated for fiscal year ending June 30, 1872, $52,

Appropriation asked for next fiscal year, $32,000.

The operations have been mostly confined to the construction c ɔomb proofs of the channel front and the excavation of the earth :he parade, depositing the same to fill in the large slope and cove n front of the fort.

The piers and arches of the seventeen bomb proofs between th sally ports, including the foundations of the casemate extensions, ɔeen constructed. The scarp wall between the sally ports was fin with the exception of an opening left in the center for temporary e ınd ingress. The piers and skew backs of both the sally port a ıave been built. The parade wall was carried two feet above th ɔf parade arches, and the concrete forming the roof surfaces c :asemate arches was nearly made ready for the mastic covering. brick sewer running under the center of the channel front has :onnected near the northwest gorge flank of Fort Wadsworth :he sewer running from the south soldiers' latrine.

The connection was made with cement pipe measuring 2 feet in liameter and 381 feet in length.

The cisterns under the casemates of the channel front have bee ıected with each other by suitable pipe and made ready to recei lrainage from the casemate roofs. The portion of earth filling to :he cover face in front of the scarp has been connected with the mate roof surface by a temporary wooden bridge, so that the eart ng over the arches can be transported and deposited without twice handled. The iron balcony for the parade of the channel fr n readiness to be put up.

During the current fiscal year it is contemplated to comple channel front of Fort Tompkins, and put it in readiness for its ba according to the existing plan, (omitting the completion of the cover face and the construction of the parade and division walls of the casemate,) to place the iron balcony around the entire parade of the work, to excavate the parade to its proper grade, and to put up the gates and side loop-holed walls in the two sally ports.

Glacis Mortar Battery, (south of Fort Tompkins,) in charge of Major Q. A. Gillmore, Corps of Engineers.—During the past fiscal year the earth work and sodding of this battery were completed, except a portion of the rear slope and the covering of the principal magazine, of which one-fourth of the concrete masonry is already laid.

The two service magazines were also finished, except the doors and granite coping to be laid on the entrance retaining walls. The battery will be finished and ready for the platforms and armament during the present working season.

No appropriation asked for next fiscal year.

Battery Hudson, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—This work, together with those on the north and south cliffs, forms a system of open earthen barbette batteries, lying exterior to Forts Tompkins and Wadsworth, and brings a powerful fire to bear upon the channel, up to and through the Narrows.

Amount appropriated for fiscal year ending June 30, 1872, $16,000.

Appropriations asked for next fiscal year, $17,000.

That portion of the battery near the light-house and west of the 15-inch center pintle platform has been cleared to give room for platforms for 15-inch guns and two service magazines. The latter have been built during the year and are complete except the doors and a portion of the earth work and sodding and the coping of the wing walls. In the extension of the battery the masonry of the two service magazines and the principal magazine is complete, except the coping wing walls. The earth excavations to form the rear slopes, and the filling over the magazines, are all in a forward state and nearly ready for sodding. It is expected that the Battery Hudson extension, and the return at the light-house, will be completed and made ready for their new armaments during the present working season.

North Cliff Battery, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations were carried on during the past fiscal year, except to clear the earth from the terreplein, where it had been washed from the unfinished slope at the north end of the battery. The earth was deposited to form the parapet. This battery may be finished according to existing plans during the present fiscal year.

South Cliff Battery, Staten Island, New York Harbor, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations were carried on during the past fiscal year, except to cut the grass and keep the gutters and cesspools open. The battery may be finished according to the existing plans during the present fiscal year.

Fort at Sandy Hook, New Jersey, in charge of Lieutenant Colonel John Newton, Corps of Engineers.—The condition of this work remains the same as at the date of the last annual report, the watchmen being the only force employed during the year.

Operations were commenced in the latter part of the month of June, 1871, for constructing additional jettees for protecting the site of the fort, $13,500 having been allotted from appropriation for contingencies of fortifications.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Mifflin, Delaware River, Pennsylvania, in charge of Lieutena onel J. D. Kurtz, Corps of Engineers.—This fort constitutes one inner line of works for the defense of Philadelphia and the nav tablishment at League Island.

Amount appropriated for fiscal year ending June 30, 1872, $26,

Appropriation asked for next fiscal year, $85,000.

During the last year two small service magazines in the dem have been commenced and continued to completion.

There have also been executed repairs and restoration of the near the fort; excavation and clearing of the ditches; re-adjustin surfaces of the 15-inch gun platforms; cleansing and purifying the ters, barracks, and store-houses; repairs of roads and bridges; cons tion of a new sluice for the use of the ditches of the work; attenti grassed surfaces, and minor repairs to scarp, parapet, and building

The present year it is proposed to complete the two demilune verses and the three gun platforms of its south face, to construct traverses and magazines of the exterior battery, with five correspon gun platforms, the storage magazine in demilune, and half of mortar battery below the fort.

Next year it is proposed to construct the new breast height wall, 15-inch gun platforms, and one earth traverse in demilune; one verse with magazine, four 15-inch gun platforms, and the sand earth embankment of the exterior battery; also to complete mo battery, for six mortars south of the fort.

Fort Delaware, Delaware River, Delaware, in charge of Lieute Colonel J. D. Kurtz, Corps of Engineers.—This work, situated on Pea-Patch Island, forms one of the chain of works constituting outer line of defense for the Delaware River.

No appropriation was made for the fiscal year ending June 30, 18

Appropriation asked for next fiscal year, $50,000.

Operations were commenced on the 12th September, 1870, to m provision for new platforms for large guns, with their magazines traverses. Six of these magazines have been constructed of conc masonry, and the embankment of the traverses has been commence

The levee on the southern and southwestern sides of the island been rebuilt for a distance of 2,450 feet; the stone revetment on sea face has been relaid and the main ditch, inside the bank, thoroug cleaned out for more than that distance.

During the present year the work on the barbette platforms, their magazines and traverses, will be completed. Next year it is posed to cleanse the remaining ditches and repair the banks on upper faces of the island; to complete the coping of dock walls; b the stone facing to the upper eastern wharf; remove upper storie the quarters on parade of fort; repair the scarp on Front I, and exe minor repairs of bridges, walls, roads, and walks, breast heights, counterscarp walls, parade, and stair towers.

Battery at Finn's Point, Delaware River, New Jersey, in charg Lieutenant Colonel J. D. Kurtz, Corps of Engineers.—The construc of this powerful earthen barbette battery for this point, to form the of the outer line of defenses across the mouth of the Delaware Ri has been delayed for want of the necessary act of cession of jurisdic of the site from the state of New Jersey. This act will be obtained coming winter, and operations pushed forward the coming season.

Amount appropriated for fiscal year ending June 30, 1872, $20,00

No appropriation asked for next fiscal year.

New Fort, opposite Fort Delaware, Delaware shore, in charge of Lie *ant Colonel J. D. Kurtz, Corps of Engineers.*—Measures have been taken for the acquisition of the site of this barbette battery, and it is expected that active operations will commence in a short time.

It is proposed, during the present fiscal year, to build a wharf and the necessary temporary buildings, and to commence the construction of the battery.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $50,000.

Fort McHenry, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work forms part of the inner line of defense for Baltimore and its dependent interests, and commands with its fire the interior waters of its harbor and the channels of approach thereto. A project for a large exterior battery for guns of the largest calibers has been prepared, and an appropriation is asked for its commencement.

No appropriation was made for the fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $25,000.

The wharf, which was much decayed by long use, has been rebuilt. The floor of the large magazine exterior to the work has been renewed. The armament of the work has remained unchanged.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a view to selecting the best location for explosive and other obstructions to the passage of hostile vessels.

Lazaretto Point, opposite Fort McHenry, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work will cross its fire with that from Fort McHenry, constituting one of the inner line of defenses of the harbor, and consists of an earthen barbette battery for the largest guns. The site selected is now the property of the United States, and an appropriation is asked for the commencement of the work.

No appropriation has as yet been made for this work.

Appropriation asked for next fiscal year, $15,000.

Fort Carroll, Baltimore Harbor, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work is situated upon the outer line for the defense of the harbor of Baltimore. It is a casemated work, and until the methods of arranging such works shall have been devised, no expenditure is proposed upon it other than for preservation.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a view to selecting the best location for explosive and other obstructions to the passage of hostile vessels.

Obstructions of the Potomac, in charge of Major Wm. P. Craighill, Corps of Engineers.—It has not yet been found practicable to make the desired experiments upon these obstructions. The material has been kept in store at Fort Foote.

Fort Foote, Potomac River, Maryland, in charge of Major Wm. P. Craighill, Corps of Engineers.—This work forms the inner line of defense of the channel of approach by water to Alexandria and the cities of Washington and Georgetown. The projects for the modification of this work and erection of an additional battery of the heaviest guns have been submitted. Arrangements have been made for the purchase of the site. The wharf has been rebuilt.

Observations have been made for the determination of the direction and force of the surface and sub surface currents in this vicinity, with a

view to selecting the best location for explosive and other obstru
to the passage of hostile vessels.

No appropriation was made for fiscal year ending June 30, 1872

Appropriation asked for next fiscal year, $25,000.

Fort Washington, Potomac River, Maryland, in charge of Major W
Craighill, Corps of Engineers.—This fort occupies a position upo
outer line of defense of the city of Washington, and requires stren
ing by the introduction of the heaviest calibers of guns. Proje
earthen barbette batteries to occupy positions immediately nort
south of the main work, as well as plans for the modification of t
isting water battery, have been prepared.

Observations have been made for the determination of the directio
force of the surface and sub-surface currents in this vicinity, with
to selecting the best location for explosive and other obstructions
passage of hostile vessels.

No appropriation was made for fiscal year ending June 30, 1872

Appropriation asked for next fiscal year, $25,000.

Fort Monroe, Old Point Comfort, Virginia, in charge of Major W
Craighill, Corps of Engineers.—This extensive work occupies an i
tant position, covering the approach to Hampton Roads, the navy
t Norfolk, and the James River. During the year, projects have
prepared for the modifications needed to adapt the work for heavy
f the largest size. The operations of the year have been confin
repairs, some of which have been quite extensive. The small l
ver the sluice way on Front 5 has been rebuilt. The casemates o
outh side of main entrance, Front 7, occupied as officers' guard
nd as prisons, have been repaired. Friction plates have been la
arbette platform No. 120. The ramps and terre plein have bee
aired. The traverse irons and friction plates of all the platforms
een cleaned and lacquered. The grass has been cut in the redoub
n the glacis. The bridges at main entrance, east entrance, and
ostern on Front No. 7 have been painted. A brick partition has
emoved in flank casemate at flagstaff bastion. Eight hundred
eet of the old wooden revetment of the redoubt have been rem
nd a revetment of earth and sods substituted. Fifteen boat lo
oil have been brought from across Mill Creek for this purpose a
eveling parade of redoubt, upon which grass seed has been sow
reakwater has been built opposite Fronts 1 and 2 of piles, sheathed
lank, and backed with large stones, sand, &c. A cistern at the
eer quarters has been cleaned and repaired. The fences around g
ngineer quarters, slopes, stable yard, as well as the shops, st
nd quarters themselves, have been repaired when required.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for the next fiscal year, $100,000.

Artesian Well at Fort Monroe, Virginia, in charge of Major Wm. P.
ill, Corps of Engineers.—Work on this well was suspended in August,
t that time the 4½-inch wrought iron tubing had been forced down t
epth of 898 feet below the level of the parade of Fort Monroe, an
uger had penetrated to a depth of 906½ feet below the same
hen work ceased on the well the machinery was all properly care
nd can be readily prepared for future operations if required.
roposed to resume this work and continue it, so long as a reaso
rospect exists of reaching pure water at a moderate depth and
he present water supply is insufficient, and it is a matter of im
nce, in time of war, to have one which will be certain and unfa

Fort Wool, Hampton Roads, Virginia, in charge of Major Willi

Craighill, Corps of Engineers.—This casemated fort unites with Fort Monroe in closing the passage to Hampton Roads, crossing its fire with the guns from that fort. Until approved projects for its completion can be devised, no further work is contemplated for it other than that necessary to preserve it from injury.

The condition of the fort is nearly the same as at the date of the last annual report. A few stones have been cut for the superstructure of the magazine at east end. Operations were suspended in August, 1870, and the rigging and gearing of the derricks were taken down and stored.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for the next fiscal year.

Fort Macon, Beaufort Harbor, North Carolina, in charge of Major Q. A. Gillmore, Corps of Engineers.—Projects for the modification of this work, in order to the introduction of an armament of the heaviest caliber of guns are now under consideration, and appropriations will be asked as soon as the detailed estimates are received.

The operations carried on at this work during the past fiscal year have been limited to the construction of a timber wharf and a jettee to protect the same, at an expense of $4,779, which amount was derived from the appropriation for contingencies of fortifications.

During the present fiscal year it is contemplated to make some necessary repairs to the casemates from contingencies of fortifications.

Fort Caswell, mouth of Cape Fear River, North Carolina, in charge of Major Q. A. Gillmore, Corps of Engineers.—This work was erected for the defense of Wilmington, North Carolina, but to render that city secure another work would be needed at the mouth of the new inlet, or perhaps at Orten's Point, on Cape Fear River. Projects for the modification of Fort Caswell have been prepared, and estimates of cost made out, but until the whole subject of the defense of this position can be carefully revised no work is proposed upon this fort.

Fort Moultrie, Charleston Harbor, South Carolina, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations have been carried on at this work during the past fiscal year.

Operations during the present year will be limited to the construction of positions for channel bearing guns with the requisite service magazines, the appropriation of March 3, 1871, of $25,000, being used for the work. An appropriation is required for the next fiscal year, to be applied in the execution of the existing plans for remodeling the work.

Amount appropriated for fiscal year ending June 30, 1872, $25,000.

Appropriation asked for next fiscal year, $40,000.

Fort Sumter, Charleston Harbor, South Carolina, in charge of Major Q. A. Gillmore, Corps of Engineers.—It is not proposed to arrange this work for casemate guns, but to slope off the mound of sand and ruins so as to fit them for an armament of heavy guns in barbette, behind sand parapets and thoroughly provided with sand traverses.

The operations carried on at this work during the past fiscal year were limited to the construction of the sand parapet on the north face, which was raised about seven feet for the entire length of the face.

During the present fiscal year it is contemplated to confine operations to the north and northeast faces in getting some portion of those faces in readiness to receive their armament. An appropriation is required for the continuation of the work next year in accordance with existing plans.

Amount appropriated for the fiscal year ending June 30, 1872, $25,000.

Appropriation asked for next fiscal year, $40,000.

Fort Johnson, Charleston Harbor, South Carolina, in charge of Major

Q. A. Gillmore, Corps of Engineers.—No operations have been carried on at this work during the past year, and no funds are available at present. An appropriation is required for the execution of the approved project for repairing and maintaining this work as at present designed, with such necessary alterations and enlargements in existing emplacements for armament as will fit them for the reception of 15-inch guns.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $5,000.

Castle Pinckney, Charleston Harbor, South Carolina, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations have been carried on at this work during the past year, and there are no funds available at the present time.

An appropriation is required to be applied in the execution of the existing plan for repairing the work and mounting guns of medium size upon wooden platforms in the several emplacements already prepared for them.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $8,500.

Fort Jackson, Savannah River, Georgia, in charge of Major Q. A. Gillmore, Corps of Engineers.—This work forms the main line of defense for the city of Savannah, and projects for its modification so as to arrange it for the largest caliber of guns, and in accordance with the system adopted, have been made and approved.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $18,000.

No operations have been carried on at this work during the past fiscal year, and there are no funds now available.

It is proposed next year to repair the masonry of the fort, renew the draw bridge, re-enforce the piers and arches of the casemates, increase the thickness of the covering mass of earth, and arrange the barbette with appropriate traverses, &c., for the reception of an armament of 15-inch guns.

Fort Pulaski, Savannah River, Georgia, in charge of Major Q. A. Gillmore, Corps of Engineers.—This is the principal work for the defense of Savannah on the outer line of the system. Projects for its modification, to arrange its barbette batteries with the necessary traverses and parados, and for the introduction of the platforms needed for guns of the largest caliber, have been prepared and approved.

Amount appropriated for fiscal year ending June 30, 1872, $26,500.

Appropriation asked for next fiscal year, $30,000.

No operations have been carried on at this work during the past fiscal year.

The operations of the present year will be confined to the construction of emplacements for channel bearing guns at, and contiguous to, the demilune salient, the appropriation of March 3, 1871, of $26,500, being available.

Fort Clinch, Amelia Island, Florida, in charge of Major Q. A. Gillmore, Corps of Engineers.—No operations have been carried on at this work during the past fiscal year, except such slight repairs as could be accomplished by the fort keeper, and there are no funds available at the present time, except a small sum allotted from the general appropriation for contingencies of fortifications, for the continued care of the work.

The projects proposed for the completion of this unfinished fort, according to the modified forms required by the system of defense recently adopted, are still held under advisement.

Fort Marion, St. Augustine, Florida, in charge of Major Q. A. Gillmore, *Corps of Engineers.*—The slight repairs ordered for this work were omitted during the past fiscal year in order to avoid the extra expense of sending mechanics and laborers from the North specially for the purpose. They will be executed during the present fiscal year, soon after operations commence at other works in that quarter.

No appropriation is requested for this work other than the sum heretofore allotted from the appropriation for contingencies of fortifications.

Fort Taylor, Key West, Florida, in charge of Lieutenant Colonel C. E. Blunt, Corps of Engineers.—This work for the defense of the important harbor of Key West is still in an unfinished condition. Projects for its modification have been prepared and approved, and they contemplate, in addition to certain meliorations of the main work, the completion of the advanced towers, and the construction of two exterior barbette batteries for heavy guns with magazine traverses.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $100,000.

Nothing has been done during the year except some necessary repairs to auxiliary buildings. The expenditure for this purpose, and for fort keepers and watchmen over public property, and contingent expenses, has been drawn from the general appropriation for contingencies of fortifications. With funds allotted from this appropriation for the present year, it is proposed during the coming season to increase the thickness of the scarp wall next the main magazines, and modify the parapet and terre plein of the western bastions to admit of the mounting of guns of the heaviest caliber, in accordance with the approved project.

Fort Jefferson, Garden Key, Tortugas, Florida, in charge of Lieutenant Colonel C. E. Blunt, Corps of Engineers.—A project with necessary drawings, &c., looking mainly to the adaptation of the barbette tier of the work to guns of large caliber, has been prepared, but is held for further advisement.

For the continuation next year of work on the officers' quarters and soldiers' barracks an appropriation is desired.

Amount appropriated for fiscal year ending June 30, 1872, $42,500.

Appropriation asked for next fiscal year, $50,000.

Nothing has been done during the year, and the fort remains in the condition reported last year. With the funds available for the present year, it is proposed to complete the sea-wall and to continue the work on the quarters and barracks.

Fort Pickens, Pensacola Harbor, Florida, in charge of Major C. B. Reese until September 22, 1870, since then of Colonel J. H. Simpson, Corps of Engineers.—This work is in fair condition. During the year necessary repairs were made to the wharf, store houses and stables. A fort keeper has been in care of the public property.

It is proposed for the next fiscal year to finish other necessary repairs of a general character, and to mature plans for the modification of the work.

No appropriation made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Fort Barrancas and redoubt, Pensacola Harbor, Florida, in charge of Major C. B. Reese until September 22, 1870, since then of Colonel J. H. Simpson, Corps of Engineers.—It is proposed for the next fiscal year to consider the question of the modification of this work, with a view to the introduction of heavier ordnance.

No appropriation made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Fort Morgan, eastern entrance to Mobile Bay, Alabama, in charge of

Major C. B. Reese until September 22, 1870, *since then of Colonel J. H. Simpson, Corps of Engineers.*—This work is in about the same condition as shown by the last annual report. During the year the slopes and ditch have been weeded and mowed. The lunette has been cleaned out; the stable, store houses, and wharf have been slightly repaired, and the property kept in good order.

It is proposed for the next fiscal year to construct a wharf and a sea-wall to protect the site, the funds for the same to be derived from the appropriation for contingencies of fortifications. Plans for the modification of this work to suit it to the modern armaments have not yet been prepared.

No special appropriation asked.

Fort Gaines, Dauphin Island, Mobile Bay, Alabama, in charge of Major C. B. Reese until September 22, 1870, *since then of Colonel J. H. Simpson, Corps of Engineers.*—This work needs complete modification to fit its emplacements for barbette guns, for the reception of the large modern armaments.

During the past year the store house has been repaired and whitewashed, and the public property properly cared for.

No operations are contemplated for the next fiscal year except care and preservation of public property and site, and the preparation of projects for the modification of the work.

For the preservation of the site an appropriation is asked.

No appropriation made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $5,000.

Fort on Ship Island, coast of Mississippi, in charge of Major C. B. Reese until September 22, 1870, *since then of Colonel J. H. Simpson, Corps of Engineers.*—This work is in the same condition as shown by the last annual report. Operations during the year have been restricted to preservation and care of public property.

No operations are contemplated for the next fiscal year except care and preservation of public property, and the preparation of projects for the modification of the work.

Fort Pike, Rigolets Pass, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—This work commands the passage by light-draught vessels through the Rigolets into Lake Pontchartrain. Projects for its modification, in accordance with the approved system, have been prepared by the board of engineers, and detailed estimates of the cost have been made out. It is proposed to effect the necessary repairs required upon this work, and to place in the curved barbette-battery a number of 10-inch rifled guns, with the proper number of traverses between them.

No appropriation made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $24,000.

No work was done during the past year. Two thousand dollars allotted for repairs during the present fiscal year, from the general appropriation for contingencies of fortifications, will be expended in making such repairs as are most urgently required to preserve the work.

Fort Macomb, Chef Menteur Pass, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—This work commands the passage through the bayou Chef Menteur into Lake Pontchartrain. Projects for the modifications needed on this work to fit it for the modern armaments have been considered by the board of engineers, and estimates of cost prepared. To put the work in the condition recommended by the board of engineers, there will be required the sum of $24,000.

No appropriation made for fiscal year ending June 30, 1872.

Appropriation asked for the next fiscal year, $24,000.

No work was done during the past year. Four thousand dollars allotted for repairs during the present fiscal year, from the general appropriation for contingencies of fortifications, will be expended in making repairs most needed.

Tower Duprés, Lake Borgne, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—No work was done here during the past year. One thousand dollars allotted for the present year, from the general appropriation for contingencies of fortifications, will be expended in making repairs.

No appropriation made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Battery Bienvenue, Lake Borgne, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—No work attempted during the past year. One thousand dollars allotted for the present fiscal year, from the general appropriation for contingencies of fortifications, will be applied to making the work habitable, and to paying a fort-keeper for preventing further depredations on the part of persons visiting the battery.

No appropriation made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Tower at Proctorsville, Lake Borgne, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—No work done during the past year. Three hundred and sixty dollars allotted for the present year, from the general appropriation for contingencies of fortifications, will be expended in paying a fort-keeper to preserve the property.

No appropriation made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Fort Jackson, Mississippi River, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—This work and Fort St. Philip, nearly opposite, are situated on the Mississippi River about sixty-five miles below New Orleans, and constitute the main defenses of that city against hostile naval expeditions. The depth of water through the bayous and lakes leading toward the city will only permit the approach of the smaller vessels carrying light armaments. The principal channel-way to the city through which a naval attack may be made is the Mississippi River. On this channel, therefore, our defenses should, as soon as possible, be made efficient.

The work at this fort during the past year consisted in repairs to levee and in care of property.

For the present year an appropriation of $50,000 is available, and will be applied to complete the unfinished water-battery, according to the approved plan, and for making further modifications recommended.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $75,000.

Fort St. Philip, Mississippi River, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—No work done during the past fiscal year. Thirty-seven thousand five hundred dollars available for work during the present year will be applied to the construction of the new battery recommended by the board of engineers. This amount will not be sufficient to complete the battery. To complete all repairs, alterations, and additions designed by the board, and approved, there will be required a further appropriation of $70,500.

Amount appropriated for fiscal year ending June 30, 1872, $37,500.

Appropriation asked for next fiscal year, $50,000.

Fort Livingston, Barataria Bay, Louisiana, in charge of Captain C. W. Howell, Corps of Engineers.—This barbette work is situated at the entrance of Barataria Bay, and was intended to prevent access to the city of New Orleans by this route, at the same time securing the anchorage for the use of our vessels of light draught. Projects for its modification and repair have been devised by the board of engineers for fortifications. These modifications look to the arrangement of its barbette-batteries for the emplacement of some large rifles and smooth bore guns. During the past year there was expended in repair of this work $202 50.

For the present year there is available the sum of $2,500 from the general appropriation for contingencies of fortifications. To carry out the approved recommendations of the board of engineers, there will be required the sum of $38,000.

Fort at Fort Point, entrance to San Francisco Harbor, California, in charge of Lieutenant Colonel C. S. Stewart, Corps of Engineers.—This is one of the principal works for the defense of the entrance to the harbor of San Francisco through the Golden Gate, the approaches to this entrance, and the inner waters of this passage. It is situated on the southern side of the channel, and consists essentially of a large casemated work and extensive exterior earthen barbette batteries for the largest guns and mortars. The casemated part of the work has been essentially finished for some years, and the barbette batteries should be pushed to completion at an early day.

Amount appropriated for fiscal year ending June 30, 1872, $50,000.

Appropriation asked for next fiscal year, $125,000.

In December, 1870, the construction of the batteries to the south of the fort was commenced. The embankment of parapets, terre pleins, traverses, &c., has been two-thirds completed for a running length of 1,324 feet. In addition the parapets and terre pleins of the mortar battery for a length of 369 feet have been nearly finished and its traverses in part embanked. In all 29,586 cubic yards of embankment have been put in place. The exterior slopes of the barbette batteries, in general, and portions of the traverses and rampart slopes have been sodded; also the exterior, superior, and interior slopes of parapets of mortar battery and portions of its traverse. Total sodding, 7,180 square yards. Part of the breast height wall has been begun, the masonry of two traverse magazines about completed, and that of eight others two-thirds finished; the foundations for twelve platforms for heavy guns put down, and twelve pintle blocks put in place. In all 1,928 cubic yards of brick, stone, and concrete masonry constructed.

The piles of the wharf have been replaced; buildings, roads, &c., repaired, and much miscellaneous work done.

Fort at Lime Point, San Francisco Harbor, California, in charge of Major George H. Mendell, Corps of Engineers.—This fort, with its detached earthen barbette works at Point Cavallo, Lime Point Ridge, and Gravelly Beach, constitute the defenses of the entrance to the harbor of San Francisco, on the northern shore of the Golden Gate. As yet no guns have been put in position along this shore, but in some of the batteries work is well advanced toward that end.

Amount appropriated for fiscal year ending June 30, 1872, $100,000.

Appropriation asked for next fiscal year, $200,000.

The work done at Lime Point during the past year may be mainly included in the following-named items, viz: construction of a wagon-road from the quarters to Gravelly Beach battery, a distance of two miles; excavation for and construction of a culvert in Gravelly Beach battery, 170 feet in length; embankment of the terre-plein and parapet of Gravelly Beach battery; construction of magazines in Gravelly Beach Valley—four completed, two unfinished; excavation for batteries on the cliffs and extension of wharf 50 feet. Gravelly Beach battery, to contain twelve 15-inch guns, is ready for the construction of platforms. The cliff batteries, to contain nine 15-inch guns, are ready for the construction of the magazines, breast-height walls and platforms.

It is expected that both these batteries will be completed during the next fiscal year, and in addition the mortar battery to contain four mortars. This battery is nearly completed now, and the timber for the platforms is on hand.

The next work to be undertaken is the barbette battery near Point Cavallo.

Fort on Alcatraz Island, San Francisco Harbor, California, in charge of Major George H. Mendell, Corps of Engineers.—This work occupies a valuable position for the defense of the entrance to, and inner waters of, the harbor of San Francisco, covering the whole of the rocky island, the shores of which rise abruptly from the water to a height sufficient to secure it from surprise. The fortifications have from their inception consisted chiefly of open barbette batteries for the heaviest guns. The recent introduction of guns so much larger than those formerly used has rendered the modification of the batteries at this work imperative.

Amount appropriated for fiscal year ending June 30, 1872, $75,000.

Appropriation asked for next fiscal year, $100,000.

During the past year, in Batteries 1 and 4, preparations were made for remodeling the defenses by the removal of gun-platforms and breast height walls. The work of cutting off the north caponnière, begun in the previous year, was completed and its conversion into a magazine traverse was commenced. In Battery 2, three service magazines were completed, as were also breast height walls for four guns, and the parapet except the sodding. In Battery 3, one service magazine was built, and the breast height walls for two guns commenced. One front pintle wooden platform for 15-inch gun was laid in Battery 2, and partially tested. The site of Battery 5 was sufficiently excavated to admit of the commencement of work on the gun platforms and other masonry. Considerable excavation was also made in Batteries 12 and 13, and the buildings and other public property on the island were kept in order and repair.

Batteries at Point San Jose, San Francisco Harbor, California, in charge of Lieutenant Colonel C. S. Stewart, Corps of Engineers.—The wood-work of the batteries continues to deteriorate necessarily. Six 42-pounder banded rifles, on iron carriages and front pintle wooden platforms, are mounted in the east battery.

No expenditures have been made during the year, and no appropriation is yet asked for the commencement of the new defenses projected for this point.

Batteries on Angel Island, San Francisco Harbor, California, in charge of Lieutenant Colonel C. S. Stewart, Corps of Engineers.—These temporary earth-works, erected during the late war, remain in the condition stated in the last annual report, with added deterioration due to the lapse of time, no expenditures having been made upon them during the year.

Two of the three works retain efficiency, and it is proposed to defer the commencement of the batteries of a permanent character projected to replace them.

No appropriation was made for fiscal year ending June 30, 1872.

No appropriation asked for next fiscal year.

Defenses of the mouth of the Columbia River, Oregon, in charge of Major G. H. Mendell until April 11, 1871; since then, of Major Henry M. Robert, *Corps of Engineers.*—These defenses consist of Fort Stevens, on the south side, and three detached earthen barbette batteries at Cape Disappointment, on the north side of the entrance. They were built during the late war, and the materials used in their construction being those chiefly used in temporary works, they require frequent repairs. The revetments of all the interior slopes and traverses, and the timbers of the magazines at Cape Disappointment, are rotten and fallen in many places. They should all be replaced the coming year.

No appropriation was made for fiscal year ending June 30, 1872.

Appropriation asked for next fiscal year, $20,000.

The only operation carried on during the past year at these works, was the erection of a picket fence around Fort Stevens.

Sea-coast mortar batteries.—The appropriations of 1870 and 1871, for sea-coast mortar batteries, amounted, in all, to the sum of $175,000. This sum has been apportioned between the important ports of Portland, Boston, New York, Philadelphia, and San Francisco, as follows:

At Portland, for the emplacement of 4 mortars	$5, 000
Boston ....do ....do.......14...do	34, 000
New York.....do ....do.......40...do	80, 000
Philadelphia .. do ....do....... 6...do	21, 000
San Francisco .do ....do.......28...do	35, 000

Making a total of ninety-two mortars in all.

Projects for the batteries for nearly all these mortars have been prepared and approved, and the constructions have been commenced at some points.

The fire from mortars is an important part of the defense of our harbors against iron-clads, and a further appropriation for batteries of this description is recommended.

Amount appropriated for fiscal year ending June 30, 1872, $100,000.

Appropriation asked for next fiscal year, $100,000.

Examinations of tidal currents.—Careful surveys and examinations to determine the strength and direction of the tidal currents in the channels opposite to and near the works of defense for our sea-ports on the Atlantic, Gulf, and Pacific shores have been made, or are still in progress, under the direction of the several officers charged with the supervision of the fortifications at the respective points, except upon the Pacific coast, where the observations were under the direction of Lieutenant Colonel B. S. Alexander, Corps of Engineers.

BOARDS OF ENGINEERS.

The board of engineers for fortifications, stationed in New York City, consisting of Colonel J. G. Barnard, Colonel G. W. Cullum, Lieutenant Colonel Z. B. Tower, and Lieutenant Colonel H. G. Wright, have been engaged during the past year upon the plans for the modifications of the sea-coast defenses and the decision and investigation of questions connected therewith.

The board of engineers for the Pacific coast, consisting of Lieutenant Colonel B. S. Alexander and the officers in charge of the construction of fortifications in San Francisco harbor, with Lieutenant Thomas H. Handbury as recorder, have been occupied with projects for the defense of the Pacific coast.

BATTALION OF ENGINEERS AND DEPOTS.

Battalion of engineers, commanded by Major Henry L. Abbot, Corps of Engineers, headquarters Willet's Point, eastern entrance to New York

Harbor.—The strength of the five companies constituting the battalion of engineers on the 30th of June, 1871, was 12 officers and 303 enlisted men; 51 recruits were needed to complete the reduced organization fixed by General Orders No. 122, series of 1870, from the War Department.

This organization, in accordance with the act of July 15, 1870, was determined to be as follows: Companies A, B, C, and E, 83 enlisted men each; Company D, 20 enlisted men; non-commissioned staff of battalion, 2 men; making a total of 354 enlisted men of engineers.

The companies of the battalion were stationed and commanded as follows: At Willet's Point, Company A, Captain Mackenzie; Company B, Captain Wm. R. King; Company C, Captain C. W. Raymond; and Company D, (a skeleton organization) under charge of the adjutant of the battalion.

Detachments of one sergeant and five first-class privates of Company D were stationed at Yerba Buena Island, California, and Jefferson Barracks, Missouri, for the purpose of guarding and caring for engineer property at those points. The detachment heretofore kept at the Military Academy for the purpose of aiding in the instruction of cadets in practical engineering, signaling, &c., was increased to a full company, and Company E selected for that purpose.

Company D having been practically disbanded by the reduction of the battalion, as mentioned above, the four companies of the battalion are now stationed at two points only—Willet's Point and West Point.

During the past year the battalion has, in common with infantry and artillery troops, been occasionally called upon for active military service, for escort duty, and to aid in enforcing the revenue and other civil laws. Careful instruction is required in the duties of its special arm to keep the engineer battalion always ready for field service, and, notwithstanding many interruptions arising from the reduction and moving of the troops, good progress has been made in field fortifications, pontoning, mining, military maneuvers, signaling, infantry drill, and in the use of torpedoes.

The duties required of the officers and troops serving at Willet's Point have been so combined and arranged that the post is rapidly acquiring the character of a school of practice for engineer officers, and is thereby adding materially to the efficiency of the service.

I would respectfully recommend that an appropriation of $1,000 be asked for the purchase of the stock used in the fabrication of siege and mining materials, and for a simple photographic apparatus for copying maps, &c., and again renew my recommendation of past years that the battalion be allowed two principal musicians, and that the seventh section of the act of July 13, 1866, taking from engineer troops the per diem paid to other soldiers when engaged in continuous labor, be repealed.

Engineer post and depot at Willet's Point, New York Harbor, commanded by Major Henry L. Abbot, Corps of Engineers.—At this post is the principal engineer depot of the Army; large quantities of bridge equipage and engineer tools and material are stored and guarded by the engineer battalion, and issued, from time to time, as required for use on public works. The old temporary buildings (originally designed for the Grant General Hospital) in which much of the property is stored have become so ruinous as to no longer serve their purpose, and a new building to replace them is now constructing. It is desirable that the ponton-boats belonging to the bridge-trains should be covered with a light roofing of boards to protect them against the weather; and also that certain parts of the bridge equipage on hand should be modified to correspond with the new pattern adopted in 1869, after thorough study of the experience gained in the war. For these objects, and for the current expenses of the depot, an appropriation of $5,000 is requested; the labor will be performed by the engineer soldiers without cost.

Work upon the public buildings has been pushed forward as fast as the funds on hand have allowed. Three new barracks have been completed, almost entirely by the labor of the engineer soldiers, thus reducing the cost nearly to that of the material used. This work will be continued during the coming year. An appropriation of $5,000 for further repairs, and one of $5,000 for a suitable chapel, is requested.

During the past year this depot has been extended to include the instruments (astronomical, geodetic, reconnoitering, &c., &c.) in use by the officers of the Corps of Engineers, all of which are now stored and issued at Willet's Point. There are many on hand which require repairs, and delay in issuing them often arises from the fact that requisitions cannot be filled until these repairs can be made at the cost of the special appropriation for which the instruments are needed. This delay will be obviated by an appropriation for "repairs of instruments," and $10,000 is requested accordingly. It will be expended from time to time, as needed, to keep a proper supply on hand suitable for issue.

This post having been constituted, by order of the Secretary of War, the torpedo school of the Army, an elaborate course of experiments was begun in 1869 with a view to determine the best and most economical methods of employing this new auxiliary in harbor and land defense. The project was drawn up by the board of engineers for fortifications, after due deliberation, and has been actively carried on by the engineer troops at very small cost to the Government. It comprises a careful experimental investigation of the whole subject. The results already arrived at are entirely satisfactory.

Use has been made during the past year of the instruments and methods to settle certain questions arising in practical sub-aqueous blasting now in progress. An appropriation of $10,000 is requested to continue the investigations.

Engineer post and depot of Jefferson Barracks, Missouri, commanded by Captain P. C. Hains, Corps of Engineers.—In accordance with General Orders No. 122, series of 1870, from the War Department, Company E, stationed at this post, was reduced and reorganized, and left this post for West Point on the 1st, and arrived at its new station on the 3d of March, 1871. The engineer property at the post is still retained there under the care of a small detachment of engineer soldiers. By General Orders No. 41, series of 1871, from the War Department, dated April 24, 1871, this post, with all the lands appertaining thereto, was transferred to the Ordnance Department.

Engineer post and depot of Yerba Buena Island, California, commanded by Captain S. M. Mansfield, Corps of Engineers.—In accordance with General Orders No. 122, series of 1870, from the War Department, Company D, battalion of engineers, stationed at this post, was reduced and the skeleton ordered temporarily to Willet's Point. In compliance with this order the reduced company left this post on the 11th, and arrived at Willet's Point on the 21st of March, 1871, leaving behind a small detachment of men to care for the engineer property still remaining on the island. In accordance with the orders of the honorable Secretary of War, as conveyed in letter of the Adjutant General of the Army to the commanding general Division of the Pacific, this post was on the 30th of June, 1871, turned over by the Engineer Department to the Quartermaster's Department, to be occupied for depot purposes or quartering troops, as circumstances might require.

RIVER AND HARBOR IMPROVEMENTS.

The appropriations with which works for the improvement of rivers and harbors have been prosecuted during the past fiscal year have been derived from the act approved July 11, 1870, in connection with such balances of former appropriations as were available for the fulfillment of contracts and the liquidation of obligations made prior to the beginning of the fiscal year. The amounts appropriated by this act for works in course of construction were applied in the continuation of these works, in accordance with previously approved plans. In the case of new works of improvement provided for by the act, steps were at once taken to prepare projects, and on their being approved the officers in charge were directed to commence operations with as little delay as possible. For a general understanding of the condition of these improvements, and also of the progress made during the year, I beg leave to refer to the summary of operations at each locality, contained in my annual report dated October 25, 1870, and to the corresponding summary submitted herewith. These summaries, together with the detailed reports of the officers in charge of works will, it is believed, furnish full and complete information in regard to the progress and condition of each improvement at the close of the fiscal year ending June 30, 1871. These detailed reports are transmitted herewith.

The examinations and surveys directed by Congress to be made at certain localities specified in section 2 of the act approved July 11, 1870, have, with a few exceptions, been completed. The reports on the greater portion of them were transmitted to Congress during the sessions of 1870–'71. Copies of these reports, together with those since received, are transmitted herewith.

By an act approved March 3, 1871, Congress made additional appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and in the fourth section of the act it was provided "That any part of the appropriations made by this act may, at the discretion of the Secretary of War, be applied during the current fiscal year." In accordance therewith the officers were instructed that in all cases of necessity, and wherever it was manifestly to the public interest, the amounts appropriated were made available at once, and applicable to the works of construction and improvement therein specified.

The execution of the examinations and surveys directed to be made at the localities named in the third section of the act were at once distributed among the officers of the corps, and on their submitting projects for surveys or examinations, with estimate of probable cost of each, certain portions of the appropriation for examinations and surveys, and for contingencies of rivers and harbors, were allotted, and suitable instructions issued. Many of these surveys and examinations have been made, and the reports have already been received, some of which are herewith transmitted. It is believed that the field-work of all will be completed during the present working season, and the reported results will be received in time to be submitted to Congress during the next session.

HARBORS ON LAKE SUPERIOR, AND ON THE WEST AND SOUTH SHORES OF LAKE MICHIGAN.

Officer in charge, Major D. C. Houston, Corps of Engineers, having under his immediate orders Captain J. W. Cuyler and Lieutenant A. M. Miller, Corps of Engineers.

1. *Du Luth Harbor, Lake Superior, Minnesota.*—The appropriation for the harbor ($60,000) is being applied to the extension of the breakwater built by the Northern Pacific Railroad Company. This work was 400 feet long, and, with the addition of 500 feet to be completed this season, will be 900 feet in length. The total length proposed for it is 3,000 feet.

The city of Du Luth is now cutting a canal through Minnesota Point, from the lake to the bay of Superior, in order to form an interior harbor or basin, having its entrance protected by the breakwater. The opening of such a water-way through Minnesota Point would divert some of the volume of discharge of the St. Louis River from the natural entrance of the bay of Superior, and also a part of the inflow and outflow of the reservoir volume of Superior Bay and St. Louis Bay, derived from the incessant variations in the level of the west end of Lake Superior. The depth of the entrance channel is closely dependent upon the volume of its discharge. Measures, therefore, have been taken to secure such a construction of the inner harbor of Du Luth and its canal as will prevent injury to the natural entrance, the improvement of which by the construction of parallel piers extending into the deep water of Lake Superior is in process of execution.

Amount appropriated by act of March 3, 1871	$60,000 00
Amount required for fiscal year ending June 30, 1873	100,000 00

(See Appendix A 1.)

2. *Superior City Harbor, Lake Superior, Wisconsin.*—The work during the year has consisted in the extension of the Minnesota pier 768 feet, and of the Wisconsin pier, 96 feet. At the close of the fiscal year the Minnesota pier was 1,888 feet, and the Wisconsin pier 736 feet in length. The work is now rapidly progressing on both piers, and it is anticipated that by the end of the season they will be extended (up to the water surface) over the bar to a depth of 12 feet water in the lake.

Amount on hand July 1, 1870	$17,962 63
Amount appropriated by act of July 11, 1870	40,000 00
Amount appropriated by act of March 3, 1871	60,000 00
Amount expended during the fiscal year ending June 30, 1871	28,753 73
Amount available July 1, 1871	89,208 90
Amount required for fiscal year ending June 30, 1873	65,000 00

(See Appendix A 2.)

3. *Ontonagon Harbor, Lake Superior, Michigan.*—A contract was made in September, 1870, for the extension of the west pier. This work will be completed the present season, making an extension of 224 feet, and exhausting the available funds. No appropriation was made for this harbor at the last session of Congress. The completion of the improvement in accordance with original plans involves the extension of the east pier 1,220 feet, and the west pier 1,896 feet. This harbor is well situated for a harbor of refuge, and in view of the increasing commerce of Lake Superior, it is recommended that the work be continued.

Amount on hand July 1, 1870	$4,409 88
Amount appropriated by act of July 11, 1870	10,000 00
Amount expended during the fiscal year ending June 30, 1871	349 92

Amount available July 1, 1871	$14,059 96
Amount required for fiscal year ending June 30, 1873	25,000 00

(See Appendix A 3.)

4. *Eagle Harbor, Lake Superior, Michigan.*—No work has been done at this harbor during the year. A contract was made in December, 1870, to remove a portion of the rock now obstructing the entrance to the harbor; work to commence on the 1st of May, 1871. The contractor has failed to carry out his contract, and the work has been suspended. It has been deemed advisable to await the results of the operations for removing rock obstructions in Hell Gate, East River, New York, before deciding upon a plan for prosecuting this work.

Amount on hand July 1, 1870	$23,706 97
Amount expended during the fiscal year ending June 30, 1871	150 40
Amount available July 1, 1871	23,556 57

(See Appendix A 4.)

5. *Marquette Harbor, Lake Superior, Michigan.*—During the year there has been added to the breakwater 200 feet, built to water-surface, and 200 of the 300 feet reported in the last annual report as without superstructure has been completed. It is proposed during the ensuing season to have the superstructure of the remaining 100 feet completed, and to extend the breakwater 650 feet sub and superstructure, giving, by June 30, 1873, a complete breakwater 1,850 feet in length, extending to 30 feet of water. The effect of this structure on the harbor is now marked, and the beneficial influence of each addition is experienced at once. The original estimate for this breakwater was $385,129 58, and the length designed, 2,050 feet; $190,000 has been appropriated, which will complete 1,850 feet, leaving only 200 feet to complete the work as intended. Owing to the increasing importance of Marquette Harbor and the necessity of its better protection, it is recommended that the work be continued to the amount of the original estimate.

Amount on hand July 1, 1870	$29,477 60
Amount appropriated by act of July 11, 1870	25,000 00
Amount appropriated by act of March 3, 1871	60,000 00
Amount expended during the fiscal year ending June 30, 1871	29,459 63
Amount available July 1, 1871	85,017 91
Amount required for fiscal year ending June 30, 1873	100,000 00

(See Appendix A 5.)

6. *Menomonee Harbor, Michigan.*—An appropriation for the improvement of this harbor was made by the act of March 3, 1871, and an examination of the locality at once undertaken to ascertain what changes, if any, had taken place since the summer of 1867. A project for improvement, consisting of a pile pier extending in a northeasterly direction to a depth of 15 feet water, in Green Bay, commencing at a point south of the center of the sand-point forming the north shore of the mouth of the river; this pier to constitute the permanent work of the improvement for the harbor, and to be extended *inward*, or connected with the south bank of the river, as experience or the rights of property-owners may hereafter determine.

A contract was entered into in June for the construction of the pier, and it is expected that at least 1,000 feet of it will be completed by the close of the present working season.

Amount appropriated by act of March 3, 1871	$25,000 00
Amount expended during the fiscal year ending June 30, 1871	227 50
Amount available July 1, 1871	24,772 50
Amount required for fiscal year ending June 30, 1873	25,000 00

(See Appendix A 6.)

7. *Green Bay Harbor, Wisconsin.*—The work at this harbor during the year has consisted in continuing the dredging south of Grassy Island so as to give a width of 200 feet, and straightening and deepening the area heretofore dredged; in revetting the channel through Grassy Island on the west side; cutting a channel 2,000 feet in length north of that island; extending the revetment on the east side 85 feet, and rip-rapping 450 feet on the east and 280 feet on the west side of the island, to a height of 18 inches above the water surface. It is proposed to dredge a channel 200 feet wide and 14 feet deep south of Grassy Island as far as the mouth of Fox River, and to widen the cut already made on the west side of the island.

The plan of improvement adopted has proved successful, and has secured a safe and commodious harbor at this point, which is of great benefit to the general commerce of the lakes. An examination of the work shows very little change in the dredged channel.

Amount on hand July 1, 1870	$12,420 68
Amount appropriated by act of July 11, 1870	17,500 00
Amount appropriated by act of March 3, 1871	17,500 00
Amount expended during the fiscal year ending June 30, 1871	28,103 89
Amount available July 1, 1871	19,316 79

Which will complete the work of improvement.

(See Appendix A 7.)

8. *Ahnepee Harbor, Lake Michigan, Wisconsin.*—A survey of this harbor was made during the season of 1870, in pursuance of the second section of the act of July 11, 1870, and a plan for its improvement, with estimate of cost, submitted to Congress in January last. An appropriation was made for the improvement by the act of March 3, 1871, and the work contracted for as soon as the necessary arrangements could be perfected. Work under the contract is now progressing favorably. The officer in charge is of the opinion that 600 feet of pier will be completed by the close of the present working season.

Amount appropriated by act of March 3, 1871	$25,000 00
Amount expended during the fiscal year ending June 30, 1871	169 40
Amount available July 1, 1871	24,830 60
Amount required for fiscal year ending June 30, 1873	50,000 00

(See Appendixes A 8 and A 23.)

9. *Two Rivers, Wisconsin.*—A survey was made of this locality, as directed by the second section of the act of July 11, 1870, and a plan for its improvement, with estimate of cost, was submitted to Congress in January last. By the act of March 3, 1871, the improvement was

provided for, and measures were at once taken to carry it out, to the extent of the appropriation. A contract was entered into in June for the construction of 400 feet of pile-pier on the east side, and 400 feet on the west side of the mouth of the river, and it is expected that the work contemplated will be completed during the present working season.

Amount appropriated by act of March 3, 1871	$25,000 00
Amount expended during the fiscal year ending June 30, 1871	31 30
Amount available July 1, 1871, and which will be absorbed by existing contracts	24,968 70
Amount required for fiscal year ending June 30, 1873	50,000 00

(See Appendixes A 9 and A 22.)

10. *Manitowoc Harbor, Wisconsin.*—During the year the north pier has been extended 128 feet, and the south pier 96 feet; in all, 7 cribs built to the water-surface. A further extension will be made this season of 96 feet to each of the piers, and superstructure will be built over the 7 cribs which were sunk last season. No further extension of the piers is needed at present, as there will be 14 feet of water at the mouth of the harbor on the completion of the present contract.

Amount on hand July 1, 1870	$370 24
Amount appropriated by act of July 11, 1870	20,000 00
Amount appropriated by act of March 3, 1871	11,000 00
Amount expended during the fiscal year ending June 30, 1871	11,271 20
Amount available July 1, 1871	20,459 04

(See Appendix A 10.)

11. *Sheboygan Harbor, Wisconsin.*—During the past fiscal year superstructure was built over the four cribs which were constructed under contract June 23, 1869, in extension of the south pier, and two cribs, each 32 feet by 20 feet, have been constructed and sunk in position over the sites occupied by the two outer cribs of the south pier, broken and carried away by storms in the fall of 1869. Additional extensions will be made during the present working season of 128 feet to the south pier, and 320 feet to the north pier, together forming a total length of 448 feet of pier-work. The work at this harbor should be finished by placing a crib pier-head, 50 by 30 feet, at the extremity of each pier.

The work, which was built prior to 1860, needs repairing for a length of 600 feet, and 5,000 cubic yards of excavation is required in the channel.

Amount on hand July 1, 1870	$7,811 84
Amount appropriated by act of July 11, 1870	15,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	7,170 85
Amount covered into Treasury under act of July 12, 1870	1,554 29
Amount required for fiscal year ending June 30, 1873	28,000 00

(See Appendix A 11.)

12. *Port Washington Harbor, Wisconsin.*—Work was commenced for the construction of this harbor, by dredging, on the 5th day of September, 1870. A portion of the proposed basin, 600 feet in length and 50 feet in width, was excavated to an average depth of 6 feet. Piles were driven, forming a dock front of 460 running feet. Six hundred and forty running feet of crib-pier work, 14 feet in width, will be constructed this season, (320 feet on each side of the channel.)

An additional appropriation of $50,000 will be required to carry out the piers to the depth of 14 feet.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	9,457 30
Amount available July 1, 1871	20,542 70
Amount required for fiscal year ending June 30, 1873	25,000 00

(See Appendix A 12.)

13. *Milwaukee Harbor, Wisconsin.*—With the exception of a few repairs, no work has been done at this harbor during the past fiscal year. Under the contracts now in force it is expected that an extension to each of the harbor piers, of 400 feet, will be completed to the water surface by the first day of December next, which will carry them out to the depth of 15 feet of water. Repairs will be made to the old pier work during the next year; also to the outer crib of the south pier, which was seriously damaged last fall by a collision.

Amount appropriated by act of July 11, 1870	$40,000 00
Amount appropriated by act of March 3, 1871	38,000 00
Amount expended during the fiscal year ending June 30, 1871	2,878 21
Amount available July 1, 1871	75,121 79

(See Appendix A 13.)

14. *Racine Harbor, Wisconsin.*—During last season the outer portion of the north pier was planked over, the compartments on the south side of the end crib of the north pier were raised and filled with stone, 60 feet of the south pier was repaired near its intersection with the shore, and the pier extension of 1867 and 1868 was ballasted with stone. Two cribs, each 64 by 20 feet, have been sunk in extension of the south pier, and two cribs of the same dimensions will be sunk during the present season, forming together a total extension to the south pier of 256 running feet. Superstructure will be built over these four cribs next spring. Repairs will be made to the old work of the north pier for a length of 206 running feet.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	2,714 35
Amount available July 1, 1871	17,285 65

(See Appendix A 14.)

15. *Kenosha Harbor, Lake Michigan, Wisconsin.*—The work done at this harbor has consisted in taking off the old superstructure from the south pier for a length of 552 running feet, and rebuilding it 12 feet in

width; also closing apertures with plank, and filling the intervals with stone.

During the month of March, 1871, the outer crib of the north pier, sunk in 1867, was broken, and the lower portion moved bodily a distance of 9 feet in a northeasterly direction. A crib 50 feet in length and 30 feet wide will be placed eastward of the displaced crib, its south face being upon the present general alignment of the north pier, and the displaced crib will be protected by close piling. The superstructure of the south pier will also be raised.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	6,692 21
Available July 1, 1871	13,307 79
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix A 15.)

16. *Chicago Harbor, Illinois.*—The construction of a breakwater for an outer harbor, in accordance with the plans of the Engineer Department, was commenced in September, 1870. During the season 23 cribs, each 50 feet long by 30 feet wide and from 18 to 26 feet deep, were placed in position, making 1,150 feet of breakwater up to the water surface. The cribs stood well during the winter. This spring 6 cribs 50 by 30 feet were placed on the return at the north end of the breakwater, making 29 cribs placed during the year. The work, including about 200 feet of superstructure, exhausted the original appropriation of $100,000.

The work is now in rapid progress under the appropriation made March 3, 1871. The contract was awarded to the Illinois Central Railroad Company. It is estimated that 2,000 feet of breakwater will be completed with the present appropriation at cost of two-thirds of the original estimate, owing to the lower price of materials.

Amount appropriated by act of July 11, 1870	$100,000 00
Amount appropriated by act of March 3, 1871	100,000 00
Amount expended during the fiscal year ending June 30, 1871	79,906 42
Amount available July 1, 1871	120,405 23
Amount required for fiscal year ending June 30, 1873	200,000 00

(See Appendix A 16.)

17. *Harbor of Refuge at Calumet, Illinois.*—Work was commenced at this harbor in August, 1870, an appropriation of $50,000 having been made by Congress July 11, 1870. The work to be done consisted in cutting a channel from the Calumet River to the lake, and in protecting the same by piers and revetment. The Calumet and Chicago Canal and Dock Company having already commenced the work of cutting a channel from the lake to the river, and entered into a contract for the purpose, the Government work was confined to the construction of piers extending into the lake, and the excavation of the channel beyond the shore-line. During the year 320 feet of crib-work was placed on the north pier and 192 feet on the south pier. The cribs for the north pier were built at Chicago and towed to Calumet and placed in position. They have been connected with the shore by a row of piling 300 feet long.

A channel 50 feet wide and 7 feet deep was cut from the lake to the river by the company last season. The effect of the freshets this spring was to widen this channel to 150 feet at the narrowest point, and increase the depth to about 9 feet. The gap in the north pier being closed up, there is no danger of this channel filling up. Vessels drawing 9 feet of water can readily enter the harbor.

During the present season it is proposed to extend the north pier 672 feet. This will make the north pier 1,300 feet in length, starting from the original shore-line; 440 feet of the south pier will also be completed. The effect of the improvement has been to cause extensive improvements at the mouth of the river, and to afford greatly increased facilities for the growing commerce of Chicago.

An additional $50,000 was appropriated by the act of Congress dated March 3, 1871, which will be principally expended by the close of the present season.

Amount appropriated by act of July 11, 1870	$50,000 00
Amount appropriated by act of March 3, 1871	50,000 00
Amount expended during the fiscal year ending June 30, 1871	34,096 93
Amount available July 1, 1871	65,903 07
Amount required for fiscal year ending June 30, 1873	75,000 00

(See Appendix A 17.)

18. *Michigan City Harbor, Indiana.*—The work at this harbor during the year has been confined to dredging between piers so as to afford additional harbor room.

It is found that continual dredging is necessary between the piers to maintain the required depth of water. The best remedy for this state of things seems to be the construction of an outer harbor. The cost of the outer harbor recommended by a board of engineers in January, 1870, is estimated at $324,000.

The funds now available are sufficient for the necessary repairs of inside work and dredging. Future appropriations should be devoted to the construction of an outer harbor.

The importance of a good harbor at this point has been fully discussed in former reports.

Amount on hand July 1, 1870	$5,915 91
Amount appropriated by act of July 11, 1870	25,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	18,999 55
Amount available July 1, 1871	26,916 36
Amount required for fiscal year ending June 30, 1873	100,000 00

(See Appendix A 18.)

19. *New Buffalo Harbor, Michigan.*—An appropriation of $5,000 was made for the improvement of this harbor by the act dated July 11, 1870, making, in addition to funds already available, $11,050. This sum being insufficient to accomplish any permanent results, it was decided to expend it in such manner as to be available in case of future appropriations. A contract was accordingly made for the construction of a pile pier into the lake on the north side of the proposed channel. This work is now in progress, and it is expected that 300 feet of pier will be completed this season.

Amount on hand July 1, 1870	$6,075 74
Amount appropriated by act of July 11, 1870	5,000 00

Amount expended during the fiscal year ending June 30, 1871,	$2,837 18
Amount available July 1, 1871	8,238 56

(See Appendix A 19.)

20. *Improvement of the Fox and Wisconsin Rivers.*—The operations now in progress are the construction of dams and dikes at the crossings of the canal proposed by Major G. K. Warren, Corps of Engineers, with a view to determining the practicability of improving the navigation of the Wisconsin River itself, and also whether that part of the canal project is feasible which relates to using the river in crossing from one side to the other. The works are not sufficiently advanced to determine these questions definitely, but it is expected that at the close of the season sufficient work will have been accomplished to decide the most practicable plan for improving this line of navigation.

Amount on hand July 1, 1870	$8,312 38
Amount appropriated by act of July 11, 1870	100,000 00
Amount expended during the fiscal year ending June 30, 1871	1,409 43
Amount available July 1, 1871	106,902 95

(See Appendix A 20.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

Major Houston was charged with and completed the following surveys directed to be made by the act of July 11, 1870, viz:

1. At the mouth of Oconto River;
2. At the mouth of Two Rivers, and
3. At the mouth of Ahnepee River.

General commerce and navigation do not require a harbor at the mouth of Oconto River, Wisconsin, as vessels can ride at anchor here during the heaviest storms, but the improvement of the mouth of the river would be a great local benefit. Peshtigo River, eight miles north, affords a good harbor with thirteen feet of water, and on the east shore of Green Bay, twelve to eighteen miles from Oconto, are situated the natural harbors of Big and Little Sturgeon, which are always accessible.

To improve the Oconto River and make it navigable for heavy-draught vessels, will require the expenditure of half a million of dollars.

The survey for a ship-canal from the head of Sturgeon Bay across the Portage to Lake Michigan, directed by act of March 3, 1871, is in progress, and will be completed this season.

(See Appendixes A 21, 22, and 23.)

21. *Grand Marais, Lake Superior, Michigan.*—An examination of this harbor has been made, in compliance with the act of March 3, 1871, and three projects have been submitted, costing, respectively:

First estimate	$481,525 00
Estimate of modified project	291,930 00
Estimate of second project	167,707 00

The reports of Major Houston are transmitted herewith, with the remark that the subject will be referred to a board of engineers for examination and report; and their recommendations will be submitted to you as soon as received.

(See Appendixes A 24 and A 25.)

HARBORS ON THE EASTERN SHORE OF LAKE MICHIGAN.

Officer in charge, Captain F. U. Farquhar, Corps of Engineers.

1. *Aux Becs Scies Harbor, Michigan.*—During the past fiscal year the wings on east ends of north and south piers were each extended 210 feet. One crib, 64 feet by 20 feet, was sunk on extension of north pier.

Dredging was commenced May 15, 1871, and the channel is now dredged to a depth of 12 feet.

During the present season two cribs, 64 feet by 20 feet, will be sunk.

The north pier should be extended 264 feet, and the south pier 328 feet, which will require an additional appropriation of $56,000. This work should be done in one season.

Amount on hand July 1, 1870	$8,280 90
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
	28,280 90
Less amount covered into the Treasury by act of July 12, 1870	5,721 50
	22,559 40
Amount expended during the fiscal year ending June 30, 1871	12,714 95
Amount available July 1, 1871	9,844 45
Amount required for fiscal year ending June 30, 1873	56,000 00

(See Appendix B 1.)

2. *Manistee Harbor, Michigan.*—With the exception of partly building one crib and repairing the old slab-work on north side of the channel nothing was done at this point, except to get ready the necessary materials for the season's work. During the present season each pier will be extended 158 feet, and the unexpended balance of money appropriated will be used in protecting the old slab-work on the north side of the channel. To finish this protection, together with the cutting off the angle on the south side, will require an additional appropriation of of $13,812 50.

Amount on hand July 1, 1870	$1,255 54
Amount appropriated by act of July 11, 1870	20,000 00
Amount appropriated by act of March 3, 1871	9,000 00
Amount expended during the fiscal year ending June 30, 1871	10,253 26
Amount available July 1, 1871	20,002 28
Amount required for fiscal year ending June 30, 1873	14,000 00

(See Appendix B 2.)

3. *Pere Marquette Harbor, Michigan.*—The superstructure of the north pier was finished last season, and the piers thoroughly re-ballasted.

Work was commenced on a pier-head for north pier, and the closing of the beach between the east end of south pier and the shore.

The recommendation for the removal of the old slab-pier on the south side of the channel, so as to widen the channel, is renewed.

Amount on hand July 1, 1870	$5,844 11
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
	25,844 11
Less amount covered into the Treasury by act of July 12, 1870	1,830 50
	24,013 61
Amount expended during the fiscal year ending June 30, 1871	$14,208 47
Amount available July 1, 1871	9,805 14
Amount required for fiscal year ending June 30, 1873	35,440 00

(See Appendix B 3.)

4. *Pentwater Harbor, Michigan.*—During the past year the superstructure of the north pier was finished, and the south pier was fully repaired. During the present season a pier-head will be built at end of the north pier, and the breach between the east end of south pier (through the old slab-pier) and the beach will be closed. Both the north and south sides of the channel should be protected with a new revetment, the old slab-revetment being in a very decayed condition.

Amount on hand July 1, 1870	$335 98
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
	20,335 98
Less amount covered into the Treasury by act of July 12, 1870, from appropriation for repairs, &c	261 73
	20,074 25
Amount expended during the fiscal year ending June 30, 1871	9,989 21
Amount available July 1, 1871	10,085 04
Amount required for fiscal year ending June 30, 1873	54,780 00

(See Appendix B 4.)

5. *White River Harbor, Michigan.*—During the year the north pier has been extended 256 feet, and the superstructure completed for the same distance; beyond this piles have been driven for a further distance of 64 feet.

During the present season it is proposed to extend the south pier 192 feet, and the north pier 128 feet. This will give each pier a total length of 810 feet beyond the beach-line. To do the dredging still necessary and the proper ballasting of the piers will require an additional appropriation of $10,000, which can be profitably expended.

Amount on hand July 1, 1870	$7,582 74
Amount appropriated by act of July 11, 1870	20,000 00
Amount appropriated by act of March 3, 1871	20,000 00
Amount received from sale of timber	680 00
	48,262 74

Less amount covered into the Treasury under act of July 12, 1870	$5,210 00
	43,052 74
Amount expended during fiscal year ending June 30, 1871	29,127 00
Available July 1, 1871	13,925 74
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix B 5.)

6. *Muskegon Harbor, Michigan.*—The north pier was extended 64 feet, and on both piers extensive repairs were made during the past year. The north pier should be re-ballasted and the old slab-piers repaired, which will cost $32,000.

Amount on hand July 1, 1870	$3,543 80
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	15,000 00
	28,575 80
Amount expended during the fiscal year ending June 30, 1871	15,030 16
Amount available July 1, 1871	13,513 64
Amount required for fiscal year ending June 30, 1873	18,500 00

(See Appendix B 6.)

7. *Grand Haven Harbor, Michigan.*—During the past year about 200 feet of the old work of the Detroit and Milwaukee Railroad Company has been repaired.

With the money already appropriated, it is proposed to finish the repairs (600 feet) to the work of 1869.

There are additional repairs and re-ballasting necessary to crib-pier, for which $5,300 will be required, and repairs to pile revetment of July, 1867, for which $36,000 will be required. A pier-head should be built to present pier, which will cost $7,000.

The necessity for a north pier to complete the improvement of this harbor has been fully set forth in previous reports. It should be 1,700 feet long, and would cost about $200,000. Of this sum $100,000 would be required for the first year.

Amount on hand July 1, 1870	$293 00
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	6,000 00
Amount expended during the fiscal year ending June 30, 1871	9,241 25
Amount available July 1, 1871	7,051 75
Amount required for fiscal year ending June 30, 1873	100,000 00

(See Appendix B 7.)

8. *Black Lake Harbor, Michigan.*—During the past year a crib 32 feet square, built up to water-surface, has been placed at end of north pier; 100 feet of crib-work connecting inner end of south pier with shore-line has also been built.

During the present season 640 feet of revetment and superstructure of end of north pier will be built. It will be necessary to finish the revetment of the channel-way, which will cost $12,500.

Amount on hand July 1, 1870	$494 47
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	12,308 19
Amount available July 1, 1871	8,186 28
Amount required for fiscal year ending June 30, 1873	12,500 00

(See Appendix B 8.)

9. *Saugatuck Harbor, Michigan.*—During the past year the revetting of the left bank of the river was completed on the plans proposed. The work is substantial, and experience has proved the plan of improvement to be correct. During the present season the work of protecting the south slab-pier will be completed. The recommendation for a north pier, to cost $59,300 98, is renewed.

Amount on hand July 1, 1870	$17,436 74
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	22,700 42
Amount available July 1, 1871	14,736 32

(See Appendix B 9.)

10. *South Haven Harbor, Michigan.*—During the last season a crib 30 feet square was built and placed at the head of the north pier, and this pier was leveled up.

During the present season one crib 50 feet by 32 feet has been placed in extension of the south pier. Before the end of the season three cribs 50 feet by 32 feet will be placed, one on the south pier and two on the north. This work, and the expense of reballasting the north pier, will entirely exhaust the unexpended balance of the appropriation. No further extension of the piers is at present recommended. The old slab and brush piers on north side interior to the work constructed by the Government should be removed, and pile revetments constructed to protect the bank. In addition to this, the channel should be deepened to 12 feet of water. The dredging will cost $32,000, and the revetment $12,138 33.

Amount available July 1, 1870	$188 12
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	8,712 12
Amount available July 1, 1871	16,476 00
Amount required for fiscal year ending June 30, 1873	44,000 00

(See Appendix B 10.)

11. *St. Joseph's Harbor, Michigan.*—During the past year the work of extending the south pier has been completed, and 315 piles have been driven. A further extension of 45 yards can be built with funds now available, which will be finished during the present season. Both north and south piers will need some reballasting next spring, for which purpose, and for repairs, $3,000 will be necessary.

Amount on hand July 1, 1870	$383 26
Amount appropriated by act of July 11, 1870	15,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	5,451 99
Amount available July 1, 1871	19,931 27
Amount required for fiscal year ending June 30, 1873	3,000 00

(See Appendix B 11.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENTS.

1. *Alpena Harbor, Michigan.*—This harbor is at the mouth of Thunder Bay River, which empties into Thunder Bay, west shore of Lake Huron. This bay forms an excellent harbor of refuge, and is much used as such by passing vessels during easterly storms. There is no necessity for any improvement here as far as the general commerce of the lakes is concerned.

In 1865 the legislature of Michigan chartered the Alpena Harbor Improvement Company. This company took possession of the mouth of Thunder Bay River, and expended $40,000 in building piers and dredging. At present the harbor facilities are reported to be ample, but all vessels drawing over 4 feet of water are required by them to pay toll and harbor charges.

(See Appendix B.)

2. By instructions from this office Captain Farquhar also made an examination at Mackinac City, Straits of Mackinac, with the view of a harbor of refuge in that vicinity. For his report, see Appendix B.

IMPROVEMENT OF SAINT MARY'S FALLS CANAL AND SAINT MARY'S RIVER—HARBORS ON LAKE HURON.

Officer in charge, Major O. M. Poe, Corps of Engineers.

1. *Saint Mary's Falls Canal and Saint Mary's River.*—Under the appropriation of $150,000, approved July 11, 1870, a contract was awarded for the removal of boulders endangering the navigation of the river. The contract was completed in the prescribed time, accomplishing much more work than was contemplated.

The remainder of this appropriation, together with that of $100,000 made by the act of Congress approved February 2 1871, will be expended under contract in enlarging the prism of the canal to an indicated width and depth, and to the construction of a revetment-wall and new guard-gates.

Operations during the year have been confined to the excavation of the canal, resulting in the removal of the following materials:

Of rock, cub. yards	30,383.17
Of gravel, cub. yards	4,307.19

A survey of the site of the canal and vicinity was made during the year.

The further sum of $250,000 was appropriated by Congress March 3, 1871. It was designed to apply this to the construction of new locks alongside those now in use, and plans for these are now in course of preparation, but no definite action having been taken by the State of Michigan for the condemnation of lands required in the enlargement of the canal, a part of the last appropriation will be expended in enlarging the prism of the canal. The authority of Congress is needed for the payment, out of the appropriation for the canal, for so much land as may be needed for the new locks.

Amount appropriated by act of July 11, 1870	$150,000 00
Amount appropriated by act of February 2, 1871	100,000 00
Amount appropriated by act of March 3, 1871	250,000 00
Amount expended during the fiscal year ending June 30, 1871	108,318 41
Amount available July 1, 1871	391,681 59
Amount required for fiscal year ending June 30, 1873	885,000 00

(See Appendix C 1.)

2. *Cheboygan Harbor, Michigan.*—In compliance with the act of July 11, 1870, a survey was made by Captain Farquhar, and an estimate submitted for this improvement. He suggested, should it be determined to improve this locality, dredging a channel from 100 to 200 feet wide and 14 feet deep to reach the same depth of water in the lake, following the natural channel of the river as far as it goes, and continuing thence in a direction perpendicular to the shore-line of the lake. He estimated the cost of such improvement at from $334,000 to $395,000, according to the width adopted, including pier-head and sheet-piling and revetment on the sides of the cut.

The appropriation of $10,000 by the act of March 3, 1871, towards this improvement, being so small, it has been decided to expend it in dredging between the locality of the piers as proposed in the above plan, but to diminish the width and reduce the depth of the cut to 9 feet.

The work of dredging is now in progress under contract. It is believed that all the dredging immediately necessary can be done during the next fiscal year for $50,000.

(See Appendixes C 2 and C 7.)

3. *Improvement of Au Sable River, Michigan.*—Work performed during the eary part of the year consisted of repairing and replacing the 18-foot wide crib at the outer end of the north pier. This pier was also levelled up and the superstructure on it finished, the height above mean low water being 5 feet. Except the outer crib, this work has stood well. Several cribs have settled to some extent, caused by the scouring action of the current, which, however, has resulted in increasing the depth of water along the harbor face at the south pier. Some damage has also been sustained by the passage of heavy rafts, catching on the south pier and tearing off timbers as well as by drift-logs pounding upon it. Much of this difficulty will be obviated when the superstructure now in progress is built. A marked improvement is visible in comparing the depth of water in the channel with that of previous years. The river inside shows an average depth of 11½ feet.

The recommendation of last year to extend the piers is renewed.

Under the appropriation of $10,000 approved March 3, 1871, a contract has been made for the superstructure of the south pier.

Amount on hand July 1, 1870	$9,089 63
Amount appropriated by act of July 11, 1870	15,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	24,403 75
Amount available July 1, 1871	9,685 88
All of which is pledged under existing contracts.	
Amount required for fiscal year ending June 30, 1873	35,000 00

(See Appendix C 3.)

4. *Improvement of Saginaw River, Michigan.*—This improvement is in an efficient state, and continues to prove valuable.

No further appropriations are at present required.

5. *Harbor of refuge on Lake Huron.*—The point on the shore of Lake Huron south of Point aux Barques, known as Port Hope, is recommended by Major Poe for the site of the proposed harbor of refuge, after a careful examination of the three localities named in his preliminary report of January, 1871.

Repeated borings at all three localities with an apparatus made efficient and trustworthy after many trials, established the existence at Port Hope of good holding-ground, better, even, than that at Sand Beach Bay; and as the locality possessed the requisite condition of near proximity to Point aux Barques, it was recommended by Major Poe, who, however, requested that the subject might be submitted to a board of engineers of high rank, before a final decision was made. As this request was in accordance with my own views, and was approved by you, a board of engineers, experienced in lake-harbor constructions, was at once convened and ordered to make personal examination of Port Hope and Sand Beach Bay, and report their views as to the site best adapted to meet the wants of navigation. Their report will be submitted to you as soon as received.

The design submitted by Major Poe aims to make the required protection from the sea by constructing a breakwater in the ordinary form of wooden cribs, filled with ballast stone. This breakwater, it is proposed, shall be 2,500 feet long, parallel with the shore-line; thence from the northern end a wing of the same character, to extend 1,500 feet toward the shore. In addition, it is proposed to construct on the north a smaller breakwater, its eastern end being southwest and distant 500 feet from the west end of the wing of the main breakwater, and its length 800 feet, extending toward the shore.

The estimated cost of the main work is	$449, 744 71
And for the auxiliary breakwater is	28, 000 00
Total	477, 744 71

As the cost of a harbor at either of the two points, Port Hope or Sand Beach Bay, will largely exceed the present appropriation of $100,000, the additional sum of $200,000 is recommended for appropriation at the next session of Congress.

6. *Survey and estimate for removing middle ground at the mouth of Black River, in Saint Clair River, Michigan.*—This survey was directed by the act of March 3, 1871, and was completed during the year; a map, with detailed estimates for improvement, having been submitted. The officer in charge proposes building a dam across Black River and dredging out a new channel at its mouth at a cost of $66,924. His estimate for the removal of the middle ground to a depth of 15 feet, (involving the excavation of 168,300 cubic yards gravel at 40 cents,) is $67,320.

To obtain a depth of 18 feet requiring the excavation of 393,800 cubic yards, at 40 cents, $157,520.

(See Appendix C 5.)

7. *Improvement of Clinton River, Michigan.*—The appropriation of July 11, 1870, ($5,000,) was expended under contract during the past year, and resulted in obtaining a channel 2,700 feet long, with an average width of 98 feet at top and 58 feet bottom, and depth of 9 feet. The sum appropriated by the act of March 3, 1871, will be expended

during the present season in making a survey of the improvement with the view of adopting the necessary measures for maintaining its efficiency.

No appropriation is recommended for the next fiscal year.

(See Appendix C 6.)

8. *Examination of the mouth of Pine River, Saginaw Bay, Michigan.*—This is a small stream emptying into Saginaw Bay, on its northern side. It has a depth of about 7 feet for a width of less than 100 feet, with only 4 feet on the bar at its entrance.

A harbor here can be of no general importance, and is not required as a harbor of refuge. A channel, to be useful, should be at least 100 feet wide at top and 7 feet deep. To dredge this will cost about $7,500.

The officer in charge made no estimate for piers, because the cost of building them is not warranted by the existing commerce of the place.

IMPROVEMENT OF THE SAINT CLAIR FLATS, LAKE SAINT CLAIR.

Agent in charge, Colonel Thomas J. Cram, Corps of Engineers, (retired.)

Saint Clair Flats Canal.—This work was completed and opened to the public on the 25th July, 1871.

A small force is kept at work during the season as a precaution in watching and caring for the newly made embankments, under the direction of the custodian in charge.

An appropriation will be required for the fiscal year ending June, 1873.

For wages of the custodian and for contingent repairs, $2,500.

(See Appendix C 8.)

HARBORS ON LAKE ERIE WEST OF DUNKIRK.

Officer in charge, Major Walter McFarland, Corps of Engineers, to April 25, 1871, since which time Captain George L. Gillespie, Corps of Engineers.

1. *Monroe Harbor, Michigan.*—During the year 8,000 cubic yards have been removed from the bar at mouth of the ship-canal, giving a good 12-foot channel into it.

Amount on hand July 1, 1870	$6,253 71
Amount expended during the fiscal year ending June 30, 1871	6,101 60
Amount available July 1, 1871	152 11

(See Appendix D 1.)

2. *Harbor of Toledo, Maumee Bay, Ohio.*—The improvement of the western channel by dredging has been carried on during the season. The excavation amounts to 54,573 cubic yards on June 30.

The balance on hand June 30, 1871, will be expended during the present fiscal year.

Required during the fiscal year ending June 30, 1873, to complete this dredging as contemplated, $20,000.

Amount on hand July 1, 1870	$121,724 23
Amount appropriated by act of July 11, 1870	50,000 00
Amount appropriated by act of March 3, 1871	50,000 00
Amount expended during fiscal year ending June 30, 1871	20,844 92

Amount available July 1, 1871	$100,879 31
Amount required for fiscal year ending June 30, 1873	20,000 00

(See Appendix D 2.)

3. *Sandusky River, Ohio.*—No further improvement of this river has been made since June 30, 1869, for the want of funds.

An appropriation of $20,000 could be profitably expended in widening the present channels through the bars of this river.

4. *Sandusky City Harbor, Ohio.*—The contract made in September, 1869, for dredging the inner channel of this harbor was completed in November, 1870, resulting in the removal of 28,192 cubic yards of material, in a cut 60 feet wide and 2,500 feet long.

The appropriation of July 11, 1870, ($10,000,) will be expended this season in excavating about 25,000 cubic yards from the channel cut in inner bar, in a cut half a mile in length and 90 feet in width.

No appropriation is recommended for the next fiscal year.

Amount on hand July 1, 1870	$9,749 81
Amount appropriated by act of July 11, 1870	10,000 00
Amount expended during fiscal year ending June 30, 1871	10,604 56
Amount available July 1, 1871	9,145 25

(See Appendix D 4.)

5. *Huron Harbor, Ohio.*—The east and west piers of this harbor have been repaired. They are now in good condition and the channel-way full 15 feet depth of water at low stage.

No appropriation for the next fiscal year is required except $1,000 as the probable annual cost of keeping the piers in repair.

Amount on hand July 1, 1870	$12,551 52
Amount expended during the fiscal year ending June 30, 1871	3,156 76
Amount available July 1, 1871	9,394 76

(See Appendix D 5.)

6. *Vermillion Harbor, Ohio.*—No funds have been available for any improvement here during the year. The piers are in fair condition, and there is ample water in the channel to meet all requirements of the commerce of the harbor.

No appropriation for the next fiscal year is required.

Probable annual cost of keeping the piers in repair, $1,000.

(See Appendix D 6.)

7. *Black River Harbor, Ohio.*—Nothing of consequence has been done during the year. The piers are in good repair, and there is a good channel with 12 feet of water to the harbor.

No appropriation for the next fiscal year is required. Probable yearly amount required to keep the piers in good condition, $1,000.

Amount on hand July 1, 1870	$7,980 05
Amount expended during fiscal year ending June 30, 1871	66 00
Amount available July 1, 1871	7,914 05

(See Appendix D 7.)

8. *Cleveland Harbor, Ohio.*—During the year the pier-head of the east

pier has been repaired, and 9,500 cubic yards of sand removed from the channel between the piers.

No further appropriation is required for the improvement of this harbor upon the plan adopted, but the commerce of Cleveland is increasing so rapidly that additional harbor facilities will be needed at no distant day.

Annual expenditure of $1,000 will probably keep the piers in repair.

Amount on hand July 1, 1870	$2,420 00
Amount appropriated by act of July 11, 1870	20,000 00
Amount expended during the fiscal year ending June 30, 1871	2,628 45
Amount available July 1, 1871	19,791 55

(See Appendix D 8.)

9. *Grand River Harbor, Ohio.*—No work has been done during the year. There is now a good channel with 12 feet of water. No appropriation for the next fiscal year is required.

Amount available July 1, 1871	$53,664 59

(See Appendix D 9.)

10. *Ashtabula Harbor, Ohio.*—Under the appropriation of $15,000 of March 3, 1871, a contract has been entered into to remove about 7,000 cubic yards of shale-rock by blasting and dredging, so as to give a depth of 12 feet at low water. This work is now in progress, and the 60-foot channel, blasted in 1869-'70, will be widened to the full distance between the piers. This will make as good a harbor as is possible to make of it.

No appropriation for the next fiscal year is required. Probable amount annually required to keep the piers in repair, $800.

Amount on hand, July 1, 1870	$150 22
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	5 00
Amount available July 1, 1871	15,145 22

(See Appendix D 10.)

11. *Conneaut Harbor, Ohio.*—The pier-head of the east pier has been repaired. Under the appropriation of $6,000 of July 11, 1870, a contract has been made for the extension of the east pier 90 feet. This work is now in progress.

No appropriation for the next fiscal year is required. The piers can be kept in repair at an annual cost of $500.

Amount on hand July 1, 1870	$2,864 15
Amount appropriated by act of July 11, 1870	6,000 00
Amount expended during fiscal year ending June 30, 1871	1,542 33
Amount available July 1, 1871	7,321 82

(See Appendix D 11.)

12. *Erie Harbor, Pennsylvania.*—During the fiscal year 9,851 cubic yards of sand were removed from the inner bar, and 15,466 cubic yards from the outer bar of this harbor, under the contract of March 29, 1867.

The repairs to the breakwater connecting the south pier with the south shore have been completed. The appropriation of July 11, 1870, has been used in part in these repairs.

An additional appropriation of $29,000 was made on March 3, 1871.

Under this, contracts have been made for removing about 60,000 cu yards from the channel across the inner bar, and for removing sunken cribs near the east end of the north pier, and extending pier eastwardly 120 feet. The channel across the inner and outer b will be widened to 350 feet (the width between the piers at the beac lights on north pier) and will have a depth of 15 feet at low stag water. The allotment of $10,000 for the protection of the penins will be expended during the year in the purchase and planting of tr and in the construction of jettees of brush and stone at the threate points.

No appropriation is required for the next fiscal year. Amount p ably required annually to keep the piers and breakwater in rep $1,500.

Amount on hand, July 1, 1870	$31, 650
Amount appropriated by act of July 11, 1870	20, 000
Amount appropriated by act of March 3, 1871	29, 000
Amount alloted for protection of peninsula from appropriation for examinations and surveys, &c., northwestern lakes, &c	10, 000
Amount expended during fiscal year ending June 30, 1871,	31, 655
Amount available July 1, 1871	58, 995

(See Appendixes D 12, 13, and 14.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

The act of July 11, 1870, directed examinations to be made at P Clinton and Rocky River, Ohio. These were made by Major McF land, Corps of Engineers, and submitted to Congress February 4, 18

The improvement he suggests for Port Clinton Harbor requires ab 4,500 feet of pier-work, at a cost of $120,000, including the deepening the entrance to Portage River to 8 feet.

To make a harbor at Rocky River, either for commercial purposes or harbor of refuge, a large amount of dredging would be required, also the construction of a protecting pier.

Major McFarland estimates the cost of a pier at $30,000, and the c of dredging a channel, 100 feet wide and 12 feet deep, from the outs of the outer bar along both sides of the island in the river, to be fr $48,000 to $132,000, according as the material to be excavated may may not prove to require blasting.

(See Appendixes D 16 and 17.)

The resurvey of Monroe Harbor, Michigan, and the survey of Maun River, above Toledo, Ohio, directed to be made by the act of March 1871, are in progress, under the direction of Captain Gillespie.

HARBORS ON LAKE ERIE, EAST OF ERIE, PENNSYLVANIA.

Officer in charge, Captain Franklin Harwood, Corps of Engineers.

1. *Dunkirk Harbor, New York.*—The west pier was secured and re-forced during the working season of 1869, and now stands in good a safe condition.

The removal of the old outer breakwater was completed in 1871; p parations to carry into effect the plan of the board of engineer offic of November 3, 1870, were made, and the work commenced at the cl of the fiscal year, 1870-'71; and by the close of the working season t day-beacon will be established, and 200 feet of breakwater laid, exhau existing appropriation.

Amount on hand, July 1, 1870	$519 00
Amount appropriated by act of July 11, 1870	25,000 00
Amount appropriated by act of March 3, 1871	25,000 00
Amount expended during fiscal year ending June 30, 1871.	25,560 00
Amount available July 1, 1871	24,954 59
Amount required for fiscal year ending June 30, 1873	141,000 00

(See Appendixes E 1 and E 2.)

2. *Buffalo Harbor, New York.*—The breakwater has been extended 783 feet during the fiscal year 1870-'71, making 1,183 feet completed at the close of the year. There will probably be completed 1,850 feet at the close of the present working season. The repair to the north pier-head, cut into by a propeller in May last, will probably be made this autumn.

Amount appropriated by act of July 11, 1870	$80,000 00
Amount appropriated by act of March 3, 1871	100,000 00
Amount expended during the fiscal year ending June 30, 1871	147,686 36
Amount available July 1, 1871,	70,056 28
Amount required for fiscal year ending June 30, 1873	176,000 00

(See Appendix E 3.)

BRIDGE ACROSS THE NIAGARA RIVER AT BUFFALO, NEW YORK.

The act of Congress of June 30, 1870, authorizing the construction and maintenance of this bridge, required that it be subject in its construction to the supervision of the Secretary of War, to whom the plans and specifications should be submitted for approval.

To supply all necessary information on the subject a board of engineer officers was convened to examine and report upon the plan and location of the bridge. Their report, and the action taken thereon, will be found in Appendix E 4.

HARBORS ON LAKE ONTARIO AND THE RIVER SAINT LAWRENCE.

Officers in charge, Major N. Bowen, Corps of Engineers, to November, 1870; Lieutenant B. D. Greene, Corps of Engineers, to January, 1871; and Major John M. Wilson, Corps of Engineers, since that month.

1. *Olcott Harbor, mouth of Eighteen-Mile Creek, New York.*—During the fiscal year the east pier has been extended 150 feet, making its total length 588 feet, and the west pier 180 feet, making its length 698 feet.

Timber and stone were purchased in the winter for the prosecution of the work in the spring. During the present season it is proposed to add 140 feet to the east and 90 feet to the west pier.

To complete the project will require, in addition to the above, that each pier be further exended 180 feet, and that 57,000 cubic yards of material be removed by dredging; the whole at a cost of $35,000.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	5,000 00
Amount expended during the fiscal year ending June 30, 1871	9,966 50
Amount available July 1, 1871	5,501 28
Amount required for fiscal year ending June 30, 1873	35,000 00

(See Appendix F 1.)

2. *Oak-Orchard Harbor, New York.*—During the last season 270 lineal feet of pier was built—150 feet on the prolongation of the east pier, and 120 feet on that of the west. During the winter stone and plank were purchased for this season's work.

In May, 1871, contracts were made for the completion of the piers and for dredging the channel. Work was resumed on the piers June 12, 1871, and two cribs were placed in position and sunk by the close of the fiscal year.

During the present season it is proposed to add 180 feet to the west pier and 120 feet to the east, and to dredge a channel 150 feet wide to the deep waters of the lake.

Amount on hand July 1, 1870	$8,732 91
Amount appropriated by act of July 11, 1870	8,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	10,998 36
Amount available July 1, 1871	15,734 55
Amount required for fiscal year ending June 30, 1873	2,500 00

(See Appendix F 2.)

3. *Charlotte Harbor, mouth of Genesee River, New York.*—During the year the east pier has been put in order by sinking two cribs at the outer end and raising the superstructure for a distance of 285 lineal feet. The west pier has been repaired at various places, and the superstructure raised for a distance of 230 lineal feet.

No further work will be done this season, but next spring the deck-plank and part of the superstructure will be renewed on the west pier, if found necessary.

Amount appropriated by act of July 11, 1870	$12,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	9,141 67
Amount available July 1, 1871	12,858 33

(See Appendix F 3.)

4. *Pultneyville Harbor, New York.*—No funds being available at the opening of the season of 1870, work was not commenced until late in the fall. Three cribs have been prepared, ready to sink, and it is proposed to complete by contract this season 180 feet of the breakwater extending from the west shore.

Amount appropriated by act of July 11, 1870	$5,000 00
Amount appropriated by act of March 3, 1871	5,000 00
Amount expended during fiscal year ending June 30, 1871	1,023 51
Amount available July 1, 1871	8,976 49
Amount required for fiscal year ending June 30, 1873	23,850 00

(See Appendix F 4.)

5. *Big Sodus Bay, New York.*—During the year the light-house crib has been repaired, 125 feet of work south of that crib overhauled and leveled, the shore end of the west pier repaired, and 312 feet of the east breakwater rebuilt.

The funds on hand will not admit of operations this season. The sum of $45,000 will be required for dredging the channel, finishing the east breakwater and making all necessary repairs, which could be profitably expended during the next fiscal year.

Amount on hand July 1, 1870	$945 39
Amount appropriated by act of July 11, 1870	5,000 00
Amount expended during the fiscal year ending June 30, 1871	4,733 64
Amount available July 1, 1871	1,211 75
Amount required for fiscal year ending June 30, 1873	45,000 00

(See Appendix F 5.)

6. *Harbor of Little Sodus, New York.*—During the year 256 feet of the west pier have been levelled up and filled with stone, and 210 feet of cribs sunk, and 100 feet of superstructure completed on the breakwater joining the pier with the west shore.

During the present season it is proposed to build a pier-head for a light, to level up the pier for a distance of 350 feet, to complete the breakwater to the west shore, and to dredge a channel 200 feet wide and 12 feet deep at mean low water.

Amount on hand July 1, 1870	$69 48
Amount appropriated by act of July 11, 1870	5,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	4,775 93
Amount available July 1, 1871	15,293 55
Amount required for fiscal year ending June 30, 1873	22,500 00

(See Appendix F 6.)

7. *Harbor of Oswego, New York.*—During the fiscal year the pier running out from the light-house has been completed, 437 feet of superstructure having been built. The old breakwater was fully repaired last season, and one crib constructed for the new outer breakwater.

Contracts have been made for the repair of the old pier, which had been badly damaged during the winter, for a breakwater in the angle near the light-house, and for stone and labor on the new outer breakwater. Work is progressing satisfactorily on all of these.

During the present season it is proposed to complete the repairs of the old breakwater, to build a short breakwater in the angle near the light-house, and to construct about 600 feet of the new breakwater for the outer harbor.

The board of engineer officers that had submitted a plan in March, 1870, for increased harbor facilities at this place, was reconvened in May last to take into consideration the proper application of the appropriation for this purpose in the act of March 3, 1871—the question being whether the breakwater should be commenced at the western end, where it connects with the shore, or at the east end opposite the entrance to the harbor.

The town of Oswego, however, having requested that the breakwater be commenced at its western end, because affording the additional harbor room so pressingly needed at an earlier day than if commenced at the eastern end, the board recommended that this request be acceded to. This recommendation was approved by you, and the work was commenced accordingly at the western end.

Amount on hand July 1, 1870	$58,149 89
Amount appropriated by act of March 3, 1871	100,000 00
Amount allotted from "examinations and surveys," &c.	6,000 00
Amount expended during the fiscal year ending June 30, 1871	37,957 38

Amount available July 1, 1871	$126,192 51
Amount required for fiscal year ending June 30, 1873	300,000 00

(See appendixes F 7 and F 8.)

8. *Harbor of Ogdensburgh, New-York.*—During the year dredging has been carried on in the Oswegatchie River below the bridge, and in the St. Lawrence, in the channel, parallel to the city docks; 2,952 cubic yards of material, hard to dredge, have been removed from the Oswegatchie; and 8,814 cubic yards of similar material, and 57,437 cubic yards of clay, sand, saw-dust, &c., from the St. Lawrence channel. During the present working season it is proposed to remove a boulder from the channel of the Oswegatchie, and to dredge such a portion of the St. Lawrence channel as the funds on hand will admit.

Amount on hand July 1, 1870	$5,394 89
Amount appropriated by act of July 11, 1870	15,000 00
Amount appropriated by act of March 3, 1871	25,000 00
Amount expended during the fiscal year ending June 30, 1871	20,394 89
Amount available July 1, 1871	25,000 00
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix F 9.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

Mouth of Salmon River, Port Ontario, New York.—A survey of this locality was made by Lieutenant B. D. Greene, Corps of Engineers, in compliance with the act of July 11, 1870.

A special report upon a survey of this locality, made in compliance with a resolution of Congress of January 17, 1868, will be found printed in Ex. Doc. H. R. No. 119, Fortieth Congress, second session, and also in my annual report of October 20, 1868.

With this report an estimate was submitted of $209,000 as the probable cost of closing the present channel and cutting a new one 200 feet wide and 12 feet deep through the sand-spit at Wind Gap, and for dredging out the middle of Selkirk Pond to 10 feet, to give harbor room.

In the report now submitted, the engineer officer in charge omits the item of dredging Selkirk Pond and makes other modifications, which reduce the estimate to $113,000.

As it does not appear that the wants of commerce and navigation require the construction of a harbor of any considerable magnitude, this estimate is limited to an improvement which shall enable vessels to pass readily into and out of the river.

(See Appendixes F 10 and F 11.)

HARBORS ON LAKE CHAMPLAIN.

Officer in charge, Lieutenant Colonel John Newton, Corps of Engineers.

1. *Plattsburgh Harbor, New York.*—During the year one crib 94 feet long and 25 feet wide has been sunk and filled with stone, and another crib, 150 feet long and 25 feet wide, has been commenced, making an addition to the breakwater of 224 feet in a northeasterly direction.

The work is done by contract. An appropriation of $23,000 will be required for the next fiscal year in order to complete the breakwater, and likewise to protect the beach from erosion and prevent the harbor from shoaling.

Amount on hand July 1, 1870	$580 85
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during the fiscal year ending June 30, 1871	6,169 30
Amount covered into Treasury	580 85
Amount available July 1, 1871	18,830 70
Amount required for fiscal year ending June 30, 1873	23,000 00

(See Appendix G 1.)

2. *Burlington Harbor, Vermont.*—During the year the breakwater has been extended in a northerly direction 171 feet, the extension being in two cribs, each 30 feet in width. These cribs will have the superstructure constructed during the present season. Two cribs, likewise during this season, are being constructed, which will extend the breakwater in a southerly direction 217 feet.

The work is done by contract.

In view of the large extension of breakwater needed in both a northerly and southerly direction, an appropriation of $60,000 for the construction of about 450 feet of breakwater can be profitably expended during the next fiscal year.

Amount on hand July 1, 1870	$5,162 14
Amount appropriated by act of July 11, 1870	25,000 00
Amount appropriated by act of March 3, 1871	30,000 00
Amount received from sale of bolts	263 98
Amount expended during the fiscal year ending June 30, 1871	18,823 21
Amount deposited in Treasury	168 44
Amount available July 1, 1871	41,434 47
Amount required for fiscal year ending June 30, 1873	60,000 00

See Appendix G 2.)

IMPROVEMENT OF THE UPPER MISSISSIPPI, OF THE MINNESOTA AND ILLINOS RIVERS, OF THE DES MOINES AND ROCK ISLAND RAPIDS, AND PRESERVATION OF THE FALLS OF SAINT ANTHONY.—CONSTRUCTION OF THE ROCK ISLAND BRIDGE.

Officer in charge, Colonel John N. Macomb, Corps of Engineers, having under his immediate orders, Captains W. H. H. Benyaurd, A. H. Burnham, and A. Stickney, Corps of Engineers.

(The improvement of the Des Moines and Rock Island Rapids and of the Illinois River were in charge of Lieutenant Colonel J. H. Wilson until September 30, 1870.)

1. *Dredge and Snag-Boats on the Upper Mississippi.*—The steamers Montana and Caffrey have rendered good service in dredging and snagging between Rock Island Rapids and St. Paul. During the present season the necessity of having boats of a lighter draught has been made more manifest by the low water, which has impeded the work at the time when it was most needed. The officer in charge suggests an appropriation for one, if not more, lighter draught boats for dredging a channel as far up as St. Paul at the lowest known stage of water.

Amount appropriated by act of July 11, 1870	$36,000 00
Amount appropriated by act of March 3, 1871	42,000 00

Amount expended during fiscal year ending June 30, 1871.	$32,935 86
Amount available July 1, 1871	47,000 00
Amount required for fiscal year ending June 30, 1873	72,000 00

(See Appendix H 1. (1)

2. *Improving Minnesota River.*—The work of removing snags from the channel of this river was resumed on the 4th September at Le Sueur and continued up the stream some ten miles. During the winter a party was employed between Patterson's Rapids and Sacred Heart Creek in removing boulders. The work was carried on under an agreement with Mr. S. A. Hooper, upon the terms of his contract of a former year.

Amount appropriated by act of July 1, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	9,903 56
Amount available July 1, 1871	10,096 44
Amount required for fiscal year ending June 30, 1873	15,000 00

(See Appendix H 2.)

3. *Improvement of Illinois River.*—During the last fiscal year operations on this river were confined to carrying out the modified project referred to in my last annual report, viz: to make an open channel navigation with a minimum depth of 4 feet. It is reported that this depth will fully meet all the requirements of the commerce of the river until the proposed enlarged canal is ready for use.

At the beginning of the fiscal year work was in progress under the contract of F. D. Van Wagenen, for dredging between Henry and Copperas Creek. The result under the contract has been a channel of 5 feet from Henry to Peoria, thirty-seven miles, and one of 4 feet for fifteen miles farther, and a channel-way for a 7-foot navigation, reaching to Copperas Creek, is now prepared if the dam be raised 6 inches higher than first proposed.

During the year a second contract was entered into for continuing the dredging of bars, &c., and the work has been in progress since January.

An estimate for the completion of the work in accordance with the present plan, *i. e.*, to make a channel 150 feet wide and 4½ feet deep in excavation, with dams to confine the water when required, amounting to $292,000, is submitted in detail in the report of the assistant in local charge of the work. Of this amount $150,000 could be profitably expended during the next fiscal year.

Amount appropriated by act of July 11, 1870	$100,000 00
Amount expended during fiscal year ending June 30, 1871.	26,270 10
Amount available July 1, 1871	73,729 90
Amount required for fiscal year ending June 30, 1873	150,000 00

(See Appendix H 3.)

4. *Improving Des Moines Rapids.*—During the past fiscal year work upon this improvement has been confined to excavation of earth and rock from prism of canal, making embankment with a protecting riprap wall, and to the construction of lower and middle locks. Work upon the guard-lock or Montrose channel has not yet been commenced.

A portion of the appropriation of $400,000, made July 11, 1870, was applied to the section-work of the canal at such points as the engineer deemed best, regard being had to the condition of the embankment and its capacity to resist the action of the river-current during the high stages of the water. Fortunately no trouble was experienced on this score.

Immediately upon the passage of the act of January 18, 1871, appropriating $341,000, work upon the prism of the canal was resumed. The engineer in local charge reports that he has "endeavored to push, with all the speed compatible with good work, the riprap wall of the embankment, in order that it (the embankment) may be protected from the effects of the ice during the coming winter. In this I have succeeded and have raised * * the embankment so as to have it safe from an overflow from anything but unusually high water. I have also completed the riprap wall on all portions of the line where the embankment was old and well settled."

The contract for work on the lower lock expiring October 20, 1870, the officer in charge employed a small force to place the lock in a condition to stand the winter. On the passage of the act of March 3, 1871, appropriating $250,000 for this improvement, steps were at once taken to resume work, proposals were invited and contracts made for the lower and the middle locks. The engineer reports that up to the close of the fiscal year the work progressed in a very satisfactory manner.

The contracts for stone used in the construction of the locks having expired August 26, 1871, the balance required during the remaining portion of the working season of that year was obtained by purchase in open market.

Proposals were invited May 15, and contract made July 1, 1871, for stone for lower lock, and a contract has been entered into for supplying cement for both locks. During the year all the castings and timber for the lock-gates have been furnished and the contracts completed.

For further details in regard to the prosecution of this work of improvement, attention is invited to the reports of the officers in charge, General J. H. Wilson for the first quarter of the fiscal year, when he was relieved by the officer now in charge, Colonel J. N. Macomb. These reports are transmitted herewith.

Amount appropriated by act of July 11, 1870	$400,000 00
Amount appropriated by act of January 18, 1871	341,000 00
Amount appropriated by act of March 3, 1871	250,000 00
Total	991,000 00
Amount expended during fiscal year ending June 30, 1871, (General Wilson)	220,000 00
Amount expended during fiscal year ending June 30, 1871, (Colonel Macomb)	481,944 06
Balance available July 1, 1871	289,055 94

The engineer officer in charge reports that this amount will be expended during the working season of 1871, in fulfillment of contracts, for work on the prism and locks, and for contingencies. He asks for an appropriation for the completion of the canal of $1,000,000.

The details upon which this estimate is based were not transmitted by the officer in charge, and owing to the late day at which his report has been received, I have not been able to procure them in season to be forwarded with this report.

(See Appendixes H 4 and H 1, (2.)

5. *Improving Rock Island Rapids.*—During the first quarter of the

fiscal year operations were confined to the removal of isolated patches and debris by the chisel-boats, and to the removal of the obstructions caused by the coffer-dams which were laid at the commencement of the work. The engineering party was engaged in testing levels for the purpose of verifying work done.

Under the appropriation of July 11, 1870, proposals were invited and contract awarded; but, owing to the death of the contractor, great delays ensued, resulting, however, in a re-letting of the work. The officer in charge reports that he has reason to believe that there will be no time lost in the completion of the work.

Immediately on the signing of this contract, work was commenced at Smith's Chain; a coffer-dam 950 feet by 250 was completed, and on September 1, 1871, the assistant in local charge reports the excavation in the pit in a fair state of progress; and work was begun on a second coffer-dam, at the "opening of Smith's Chain." On the completion of work at Smith's Chain it is contemplated, before the close of navigation, to improve patches between Sycamore and Smith's Chains, and those near Crab Island and St. Louis Chains.

For perfecting this improvement and meeting all probable contingencies in closing up the work, such as clearing out all patches of rock between the places already improved, &c., the officer in charge asks for an appropriation of $100,000.

Amount appropriated by act of July 11, 1870	$150,000	00
Amount appropriated by act of March 3, 1871	150,000	00
Amount expended during fiscal year ending June 30, 1871	8,989	56
Amount available July 1, 1871	273,000	00
Amount required for fiscal year ending June 30, 1873	100,000	00

(See Appendix H 5.)

6. *Preservation of the Falls of St. Anthony.*—The work of closing the tunnel was commenced during the fiscal year, and progressed favorably until cold weather set in. The balance of appropriation was to be applied to building the apron for the protection of the falls.

At the opening of the present season, work was resumed at the tunnel, and has progressed favorably. Just after the close of the fiscal year certain newly-discovered weak points were developed, which caused a diversion of the labors of the working party, and with the well-directed efforts of the assistant the havoc threatened by this new danger was averted. Surveys of these weak points are now in progress.

The officer in charge reports that estimates for the further prosecution of this work will depend upon the results of the surveys and examinations above referred to.

Amount appropriated by act of July 11, 1870	$50,000	00
Amount appropriated by act of March 3, 1871	50,000	00
Amount expended during fiscal year ending June 30, 1871	61,425	00
Amount available July 1, 1871	38,574	17

(See Appendix H 6.)

7. *Rock Island Bridge.*—The two divisions of this work have been under the immediate charge of Captain Benyaurd, in charge of the superstructure, and Captain Stickney, of the substructure.

The completion of the superstructure has met with unexpected delay on the part of the contractors in the manufacture of the iron-work

Extension of time was granted them, and the entire work will probably be completed during the current fiscal year.

The substructure has progressed favorably, and the unfinished pier and abutments will be completed in ample time for the superstructure.

The joint resolution in relation to this bridge, approved July 20, 1868, requires that the expenditures by the United States for the construction of this bridge shall not exceed one million of dollars. This sum has been appropriated, and the officer in charge reports that he has no doubt it will be ample for the completion of the work.

Amount available July 1, 1870	$598,986 47
Amount appropriated by act of July 11, 1870	300,000 00
	898,986 47
Amount expended during fiscal year ending June 30, 1871	169,748 60
Amount available July 1, 1871	729,237 87

(See Appendix H 7.)

EXAMINATIONS AND SURVEYS.

The survey of a ship-canal route from Hennepin, on the Illinois River, to Rock Island, on the Mississippi, via Geneseo, has been made under the orders of Colonel Macomb, in compliance with the act of July 11, 1870, showing a length for such a canal of sixty-five miles, with a navigable feeder from Rock River, at Dixon, of thirty-eight miles.

Estimates are made for a ship-canal 160 feet wide and 7 feet deep, with locks 350 by 75 feet, and for a navigable feeder, amounting to $12,500,000.

For a commercial canal 60 feet wide and 6 feet deep, with locks 150 by 21 feet, the estimated cost, including feeder, is $3,900,000.

Examinations above the Falls of St. Anthony, and between that and the mouth of Minnesota River, and also of the Minnesota River, have also been made this season.

(See Appendix H 8.)

IMPROVEMENT OF THE MISSISSIPPI, MISSOURI, AND ARKANSAS RIVERS, AND OF RIVERS IN THE STATE OF ARKANSAS.

Officer in charge, Lieutentant Colonel W. F. Raynolds, Corps of Engineers, who has under his immediate orders Captains C. R. Suter and C. J. Allen, Corps of Engineers.

The removing and destroying snags, cutting trees to prevent the formation of snags, and dredging bars in these streams was continued during the year. Four boats operated in the Missouri River, from St. Joseph's to the mouth of the river, until November, and renewed operations in June, and have since continued work between Omaha and the mouth.

Operations in the Mississippi, last summer and autumn, extended from Keokuk to Vicksburgh, and in the Arkansas as far up as Illinois Bayou. One of the snag-boats worked in the White River, clearing that stream of the most troublesome snags as far up as Des Arcs. Boats will be sent to the Ouachita, St. Francis, White, Black, and Little Red Rivers at the close of the autumn.

Of the snag-boats now on hand but one is suited for operations in the smaller streams during low water, and the officer in charge recommends the construction of two additional boats of light draught.

In a communication from him of the 19th October, (see Appendix I 13,) Lieutenant Colonel Raynolds urgently recommends that in rebuilding the hulls of the large snag-boats, which must soon be commenced, iron should be used, by which their draught can be reduced from 4½ feet to 2½ feet, and their efficiency be very much increased. For carrying this proposition into effect he submits an estimate of $150,000 for three of the boats.

Table showing the work done by United States dredge and snag boats during the fiscal year ending June 30, 1871.

Date.	Name of boats.	Rivers.	No. snags pulled.	Weight in tons.	Trees cut down.	Drift piles removed.
From July 29 to December 17, 1870.	R. E. De Russy..	Mississippi ... Missouri...... White	959	24,193	1,162	7
From August 9, 1870, to January 21, 1871.	S. H. Long.	Mississippi ... Missouri...... Arkansas	886	14,055	5,533	14
From August 3 to December 21, 1870; and June 13 to 30, 1871.	J. J. Abert......	Mississippi ... Missouri......	1,187	8,458	4,380	28
From August 16, 1870, to January 16, 1871; and from May 31 to June 14, 1871.	S. Thayer.......	Mississippi ... Missouri...... Arkansas.....	475	4,138	798	3
From July 28 to November 19, 1870; and from June 17 to 30, 1871.	Octavia.........	Missouri...... Mississippi ...	......	....	5,899	......
Total	....	....	3,507	50,845	17,774	52

Amount appropriated by act of July 11, 1870	$150,000 00
Amount appropriated by act of March 3, 1871..........	150,000 00
Amount expended from July 12, 1870, to June 30, 1871..	181,341 91
Amount available July 1, 1871	141,169 97
Amount required for fiscal year ending June 30, 1873 ...	750,000 00

(See Appendix I 1.)

2. *Improvement of the White, Black, and Little Red Rivers, Arkansas.*—The act of Congress of March 3, 1871, appropriates $10,000 for this purpose. The lightest draught snag-boat of the fleet will be sent into these streams as soon as it can be spared from its work on the Missouri and Arkansas. But this appropriation can only keep it at work for about two months, during which it can do but comparatively little service.

(Appendixes I 9, 10, and 11.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

The following examinations and surveys embraced in the second section of the act of July 11, 1870, were completed during the year:

1. At St. Louis and Alton Harbors, Mississippi River, between Alton and the mouth of the Maremec River. The survey of the Mississippi River between these points, including the harbor of St. Louis, was necessarily incomplete, owing to the limited time and funds at command. To reach a satisfactory conclusion as to the plan for, and cost of, securing a permanently improved condition of the Mississippi River within the limits named, requires the thorough, systematic survey recommended by Lieutenant Colonel Raynolds and his assistant, Captain Allen.

The recommendations of Colonel Raynolds to improve the harbor at Alton, by closing the channel west of Ellis Island, opposite Alton, by a cheaply constructed dam; to diminish the abrasion of the river-banks opposite the mouth of the Missouri River, by clearing Mobile Chute and the slough west of Maple Island of snags and other obstructions to the free flow of water, and to diminish the scour in Sawyer's Bend by clearing the Pocket Chute of similar obstructions, are all concurred in.

The re-opening of Cabaret Slough is desirable, but until the detailed survey recommended is made, no proper project for this or for other works, except those named above, can be prepared.

There was appropriated for the improvement of the Mississippi River in the vicinity of St. Louis, in 1836, $15,000; in 1837, $35,000; and in 1844, $25,000; in all, $75,000; and it appears from a statement in a report to the City Council of St. Louis, in 1869, that the city had expended for various works for the improvement of the harbor, up to that date, $840,121.

(See Appendix I 2.)

A detailed survey of Cabaret Slough is now in progress, under the immediate charge of Captain C. J. Allen, Corps of Engineers.

2. At Osage River, Missouri. (See Appendix I 3.)

3. At Ouachita, Little Missouri, and Petit Jean Rivers, Arkansas. (See Appendixes I 4, 5, and 6.)

4. Surveys and examinations of the bars and other obstacles to navigation of the Cache, St. Francis, Little Red, White, and Black Rivers, Arkansas. (See Appendixes I 7, 8, 9, 10, and 11.)

The following examinations and surveys directed by the act of March 3, 1871, are now in progress:

1. Survey of White River from Buffalo Shoals to the mouth of James Fork, Missouri.
2. At Black River, Missouri, to Poplar Bluff.
3. At Current River, Missouri, from its mouth to Van Buren.
4. At Fourche la Faive River, Arkansas.
5. At Camden, Arkansas, to Trinity, Louisiana, on Ouachita River.
6. At Cuivre River, Missouri, from its mouth to Moscow Mills.
7. At Bayou Bartholomew, from its mouth to the Arkansas State line.

An examination and survey of the Mississippi River near Vicksburgh has been made by Captain C. R. Suter, Corps of Engineers, with the view of determining the best means of stopping the threatened cut-off in the river in that vicinity. One of the effects of such cut-off will be to transfer the city-landing two or three miles below its present position.

The evil threatened is one of great magnitude to Vicksburgh. The report was submitted to Congress March 6, 1871.

(See Appendix I 12.)

IMPROVEMENT OF THE OHIO RIVER.

Officer in charge, Major William E. Merrill, Corps of Engineers.

Of the works in progress at the commencement of the fiscal year the dikes at Beaver Shoals, at Rising Sun, and at Warsaw, have been finished. The dike at Medoc Bar is not quite completed, the contractor for this work having failed to complete his contract in the specified time.

Under the appropriation of July 11, 1870, contracts were made for building a dam to close the left chute of the river at Brunot's Island, near Pittsburgh, for building a dike at Twin Islands, and for dredging at Merriman's Ripple and Deadman's Island. The dike at Twins has been built, and the dredging at Deadman's has been completed. No regular snagging operations were attempted last year, but a number of dangerous obstructions were removed from the river, in cases admitting of no delay.

Under the appropriation of March 3, 1871, contracts have been made for extending the dike at the lower end of the Upper Twin, and for building a dam to close the left chute of the river at Marietta Island. Contracts have also been made for the services of two light-draught steamboats to be employed in removing obstructions, one above and the other below the falls.

Detailed surveys of places requiring immediate improvement are being made, to furnish data for the economical application of future appropriations.

The officer in charge urgently recommends that larger appropriations than those of the last two years be made for the improvement of this great river, and is confident that the sum asked for can be expended with the greatest advantage during the ensuing fiscal year.

Amount on hand July 1, 1870	$40,547 61
Amount appropriated by act of July 11, 1870	50,000 00
Amount appropriated by act of March 3, 1871	50,000 00
Allotted for surveys, &c	3,000 00
Received from sales	207 00
Amount expended during the fiscal year ending June 30, 1871	68,280 07
Amount available July 1, 1871	75,474 54

Amount required for fiscal year ending June 30, 1873:

For building dams above the falls	$144,500 00
For building dams below the falls	195,000 00
For current expenses and repairs	12,000 00
For new survey and inspection steamer	12,000 00

(See Appendix K 1.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

At the mouth of the Muskingum River, Ohio, in compliance with act of July 11, 1870.—The object of this examination was to determine definitely the long-agitated question as to which of the two channels of the Ohio River at Marietta Island should be closed in the improvement of the river in that vicinity. In view of the importance of the subject a board of engineer officers in session at Cincinnati were instructed to visit and report upon the questions involved, and in concurrence with their opinion, after careful consideration of the subject, directions were given for building a low-water dam across the Virginia channel of the river, a little below the head of Marietta Island.

(See Appendixes K 2 and K 3.)

The third section of the act of March 3, 1871, provides for the survey of the Monongahela River, from New Geneva, in Pennsylvania, to Morgantown, in West Virginia, and also a survey at the mouth of the Licking River as a harbor of refuge. These are in progress under the charge of Colonel Merrill.

WATER-GAUGES ON THE MISSISSIPPI RIVER AND ITS PRINCIPAL TRIBUTARIES.

Officer in charge, Major William E. Merrill, Corps of Engineers.

The act of Congress of 21st January, 1871, directed the establishment of water-gauges at the following points on the Mississippi River, viz, St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburgh, Red River Landing, Baton Rouge, and Carrollton; and at the following points on the principal tributaries, viz, at Fort Leavenworth, on the Missouri; Rock Island, on the Upper Mississippi; Louisville, on the Ohio; Florence, on the Tennessee; Jacksonport, on the White; Little Rock, on the Arkansas, and Alexandria, on the Red River. Owing to the continued high water that prevailed throughout the remainder of the fiscal year, the work of establishing these gauges was necessarily postponed until the annual low-water period. They will all be established by the close of the present month.

BRIDGING THE OHIO RIVER.

A board composed of Majors G. K. Warren, G. Weitzel, and W. E. Merrill, Corps of Engineers, was constituted in compliance with the fifth section of the act of July 11, 1870, to examine all bridges now erected, or being erected, across the Ohio River, and to report whether such bridges do or will interfere with the free and safe navigation of the river, and if so, what modification of span and elevation will be required to prevent obstruction. Their reports upon this subject will be found in Appendix K 4. These reports were transmitted to Congress and printed.

The act of Congress of 3d March, 1871, requires the Newport and Cincinnati bridge to be so constructed that the channel-span of 400 feet, as then located, shall have, under that span, a clear headway at low water of 100 feet, and further requires the bridge to fulfill certain other conditions. The bridge-company having submitted to the Secretary of War a modified plan of the bridge, which, upon examination by the board of engineers named above, having been found to conform to all the requirements of the act of Congress, you approved the plan on the 23d August last, and the bridge-company was duly notified thereof.

IMPROVEMENT OF THE NAVIGATION OF THE FALLS OF THE OHIO, AND ENLARGEMENT OF THE LOUISVILLE AND PORTLAND CANAL—IMPROVEMENT OF THE CUMBERLAND RIVER.

Officer in charge, Major G. Weitzel, Corps of Engineers.

1. *Improvements at the Falls of the Ohio.*—Since the last annual report the work under contract for the enlargement of the entrance to the Louisville and Portland Canal, and the completion of the new locks, has been nearly completed. The guard-gates at the head of the canal have been completed.

Section No. 1 of the prism of the canal has been enlarged, and about one-half the work on the enlargement of the remainder of the prism has been done.

The construction of the new side-walls, where the old side-walls were removed to widen the canal; the construction of a passage through the draw of the railroad-bridge for high stages of water; the completion of the excavation in the new branch of the basin; the excavation of the ledge of rocks at the foot of the locks; the construction of the guide-wall at the same point, and the construction of the dam from the head of Sand Island to the Indiana shore, have all been placed under contract, and these works are all in progress.

The appropriation of $200,000 made by the act of January 18, 1871, and $250,000 made by the act of March 3, 1871, will be expended on these works.

Amount estimated as the cost of these improvements (see last annual report) is	$1,243,500 00
Of which there was allotted from appropriations of 1868 and 1869	263,200 00
Appropriated by act of July 11, 1870	250,000 00
Appropriated by act of January 18, 1871	200,000 00
Appropriated by act of March 3, 1871	250,000 00
Amount still required to complete the work	300,000 00
	1,263,200 00
Excess over original estimate	19,700 00

This excess the officer in charge thinks attributable to the insufficiency of the means available to carry on the work with greater rapidity.

Amount received during the fiscal year	$353,200 00
Expenditures during the same period	258,830 23
Remaining July 1, 1871	450,000 00
Required for the fiscal year ending June 30, 1873, and which can be profitably expended, and which will complete the work	300,000 00

(See Appendix L 1.)

2. *Improvement of the Cumberland River below Nashville, Tennessee.*—Contracts have been entered into for removing the old pier-foundation at Nashville, and for removing the obstructions at Nashville and Gower's Island, and at Harpeth Shoals, as far as the means available will permit. The preparations for doing the work have been commenced, and the officer in charge believes that if the stage of the river proves to be favorable the work will be completed during the present season.

Amount estimated as the cost of this work (see special report survey of the Cumberland River, of January 20, 1871)	$248,821 00
Appropriated by act of March 3, 1871	30,000 00
Amount still required	218,821 00

No money was received and none expended during the fiscal year.

Remaining July 1, 1871	$30,000 00
Required for the fiscal year ending June 30, 1873	218,821 00

(See Appendix L 2.)

SURVEYS AND EXAMINATIONS FOR IMPROVEMENT.

Under the provisions of act of July 11, 1870, Major Weitzel was charged with the survey—

1. Of the Cumberland River, from its mouth to the head of navigation. (See Appendix L 3.)

2. Of the Wabash River, from its mouth to the town of Wabash, Indiana. (See Appendix L 4.)

Reports upon the progress of these surveys were submitted to Congress in February last, and the act of March 3, 1871, directed their completion.

The officer in charge reports that the field-work of both will be completed and special reports submitted in time to be laid before Congress at its next session.

(See Appendixes L 5 and L 6.)

3. *Survey of the French Broad River, Tennessee*, in compliance with act of July 11, 1870. This was completed and the report transmitted to Congress in February last.

The officer in charge estimates that it would cost not less than $150,000 to make this river navigable for steamboats from Dandridge to its mouth. It appears from his report that the trade of this river is small.

(See Appendix L 7.)

IMPROVEMENT OF THE TENNESSEE RIVER.

Officers in charge, Major G. Weitzel, Corps of Engineers, to May 24, 1871, since which time Major Walter McFarland, who has under his immediate orders Captain L. C. Overman and Lieutenants J. F. Gregory and Benjamin D. Greene, Corps of Engineers.

The work done during the year at the various points at which contracts have been entered into is as follows:

Ross's Tow Head.—Nothing.

Tumbling Shoals.—Nothing.

The Neck.—About 4,000 cubic yards of material have been removed, which nearly completes the work at this point.

The Pot.—The improvement here is virtually completed so far as intended, and there are a few hundred yards of gravel still to be removed. Boatmen state that this has ceased to be an obstacle.

Colbert Shoals.—About 500 cubic yards of rock have been removed from Hoop-pole Reach, and nearly 10,000 cubic yards of rock formed into riprap dams between Tow Head No. 1 and the left bank, and at the foot of Colbert Shoals, leaving about 5,000 cubic yards yet to be added to them.

Bee Tree Shoals.—About 2,000 cubic yards of stone have been formed into a riprap dam, which nearly completes it. Some 700 cubic yards of rock are still to be excavated from the bed of the channel. Until the effects of the improvements now being made in this part of the river are observed, it is not deemed necessary to ask for any further appropriation for them.

An examination of the Tennessee River between Chattanooga and Kingston, with a view to its improvement, was made in the spring of this year, and a project for the application of the allotment of $35,000 to this part of the river presented and approved. (See Appendix M 1.)

Since the close of the fiscal year, proposals were advertised for the work, but owing to the excessive bids received they were rejected and proposals again invited.

As the cost of completing the improvement will exceed the amount now available, an additional appropriation of $25,000 is asked.

Until the Muscle Shoals are opened, the amount of commerce benefited by the improvement of the river above that obstruction will not be, comparatively, very great. The opening of these shoals to navigation would, however, convert the commerce of the Upper Tennessee from its present character into one of national magnitude.

EXAMINATIONS AND SURVEYS.

The following, directed to be made by the act of March 3, 1871, are in charge of Major McFarland:

1. *Tennessee River, from Brown's Ferry, Alabama, to Florence.*

2. *Examination and survey of the Coosa, Etowah, and Oostenaula Rivers.*
3. *Canal survey from the Tennessee to the Coosa.*
4. *Canal survey from the Etowah to the Ocmulgee.*

The first has been finished, and progress has been made in the others, excepting the last, but the officer in charge expects that all will be completed and reported upon by the end of the calendar year.

Mr. H. C. Fillebrown, assistant civil engineer, in immediate charge of the survey of the Coosa River, was drowned on the 11th of August last, at the rapids of the Coosa, twenty miles below the crossing of the Selma Railroad, while making, in company with Major McFarland, an examination of that part of the river which he had surveyed last season. Mr. Fillebrown had been for many years past employed, at intervals, in surveys and explorations under this office. His intelligence, industry, and ability in the performance of his duties, deserves acknowledgment.

IMPROVEMENT OF THE MOUTH OF THE MISSISSIPPI RIVER—IMPROVEMENT OF BAYOU TECHE, LOUISIANA, AND OF GALVESTON HARBOR, TEXAS.

Officers in charge, Captain C. W. Howell, Corps of Engineers, who has under his immediate orders Lieutenants H. M. Adams and E. A. Woodruff, Corps of Engineers.

The new dredging machinery devised by Captain Howell was attached to the dredge-boat "Essayons," and general repairs to the vessel completed before the 15th of October, 1870. The outbreak of yellow fever on board the dredge-boat greatly delayed further operations until November 19. Only four days of this time were made available for dredging on the bar at Southwest Pass, viz: October 31, November 1, 2, and 3, when 28¼ hours' work resulted in the excavation of about 22,400 cubic yards of the bar deposit and the formation of a channel across the bar 50 feet wide and 19 feet deep.

Until February 4, 1871, this depth of 19 feet measured at mean low tide was maintained and the width of channel, which had been steadily increased, was 260 feet. The channel was perfectly straight, and to define its limits a line of spar-buoys was located on either side.

February 4, the dredge-boat ran foul of a hidden wreck and sustained serious damage that required the work of a month to repair.

Work at Southwest Pass was resumed March 10, with a channel but 15 feet deep. From that date until March 26, effective work was prevented by the manner in which vessels were taken across the bar or grounded on it.

A thorough blockade of the pass was imminent and could only be avoided by subordinating all other interests to the work of dredging.

On the 27th of March, Captain Howell placed an officer on duty at Southwest Pass with instructions to control its commercial use to such extent as to insure the work of dredging from further interruption.

After some demur all parties submitted to this necessary assumption of authority, and on March 30 there was made available a channel 100 feet wide and 18 feet deep.

It is very important at times in the prosecution of public works of improvement that the officer charged with them should have entire control of their use for commercial or other purposes. Occasions may sometimes favor the officer, as in the case just cited, in assuming control, but in general it would be better to provide for such cases by suitable legislative enactments, giving the officer authority to act, and prescribing certain penalties to aid in enforcing the authority. The subject is earnestly recommended to the attention of Congress.

From March 27 to June 30, work was continued with repeated interruptions of from one to five days' duration, caused by stormy weather. During a greater part of this time a channel over 200 feet wide and 18 feet deep was maintained. On several occasions the effects of the work were nearly obliterated by storms, and afterward the channel restored to the necessary width and depth by a few days' work. On the 30th of June the channel was 250 feet wide and 18½ feet deep at mean low tide.

A new dredge-boat has been contracted for, and will be ready for work about the 1st of January, 1872. It will only differ from the "Essayons" in depth of hold, (being calculated to draw 15 feet light, and to ballast so as to sink to 20 feet, and allow the excavating propeller to cut to 22 feet direct,) and in minor details of machinery. The cost, delivered, will be $218,300.

During the summer, and perhaps until the 1st of November, 1871, it is proposed to suspend work on the bar and lay the "Essayons" up at New Orleans. It is thought that during the low water in the river the channel now available will not materially shoal. When necessary, work will be recommenced.

On June 30, 1871, there was available for the work for the present year	$307,278 80
An additional appropriation is asked to carry on the work until June 30, 1872, of	30,000 00
Amount required for the fiscal year ending June 30, 1873.	125,000 00

(See Appendix N 1.)

2. *Improvement of Bayou Teche, Louisiana.*—This work was commenced February 15, 1871, and all obstructions removed from the bayou as far up from its mouth as the town of New Iberia, before the close of the fiscal year.

This work will be continued during the present year until completed. Of the appropriation made July 11, 1870, there yet remains unexpended $8,876 17, which amount will be more than sufficient to complete the work.

Amount appropriated by act of July 11, 1870	$17,500 00
Amount expended during the fiscal year ending June 30, 1871	8,623 83
Amount available July 1, 1871	8,876 17

Which will complete the work.

(See Appendix N 1.)

3. *Improvement of Galveston Harbor, Texas.*–All efforts to have this work done by contract having failed, and no dredge-boats or scows being available for hire, it became necessary to build all boats and machinery required for the work.

These are now in course of construction, and will probably be available for work about the 15th of September, 1871.

Amount appropriated by act of July 11, 1870	$25,000 00
Amount appropriated by act of March 3, 1871	20,000 00
Amount expended during the fiscal year ending June 30, 1871	176 76
Amount available July 1, 1871	44,823 24
Amount asked for current year, (1872)	4,000 00
Amount required for fiscal year ending June 30, 1873	16,000 00

(See Appendix N 1.)

Ship canal from the Mississippi River, near Fort St. Philip, to a point near Breton Island, in the Gulf of Mexico.—In consequence of a communication from the Committee on Commerce of the Senate, referred to this office, inclosing a resolution of the Senate of the 14th of December last, instructing that committee to inquire into the expediency of constructing a canal in this locality, Captain Howell was instructed to make an examination of the project. After collecting all attainable information, he made an examination of Breton Island Pass, the proposed debouche of the canal, but found that a detailed survey of the whole route would be required before taking further action. The sum of $10,000 was allotted for this purpose from the appropriation for examinations and surveys, and the survey is now in progress. (See Appendix N 2.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

Captain Howell was charged with and has completed the following, directed to be made by the act of July 11, 1870:

1. *Cypress Bayou, Texas.*—In January, 1871, Lieutenant E. A. Woodruff, Corps of Engineers, proceeded to Jefferson, Texas, for the purpose of commencing this survey. He was prevented from executing the work by high water in the bayou. The continuance of high water has made it necessary to delay further action until October or November of the present year. (See Appendix N.)

2. *Route of a ship-canal "from the mouth of Bayou St. John, Louisiana, through Lake Pontchartrain and the Rigolets to Ship Island."*—It appears from this examination that the route is unfavorable for a ship-canal, owing to the length of under water excavation required through an unstable material exposed to the action of the waves and currents, the bars at the head, and debouche of the Rigolets, and the shoals at the western extremity of Mississippi Sound. (See Appendix N 3.)

3. *Survey of Pass Cavalle, the entrance to Indianola Harbor, Texas.*—This was made by Lieutenant E. A. Woodruff, Corps of Engineers. The expenditure necessary to carry out any plan of improvement will be very great, and the success very questionable. (See Appendix N 4.)

4. *Examination of Corpus Christi, Texas.*—This examination was made by Lieutenant E. A. Woodruff, Corps of Engineers.

No plan of improvement was submitted by him since. Aransas Pass, which is less unfavorably situated for improvement, will give entrance to the same port, (Corpus Christi,) and, besides, to the port of Rockport. (See Appendix N 4.)

5. *Examination and survey of Aransas Pass, Texas, by Lieutenant E. A. Woodruff, Corps of Engineers.*—A plan and estimate of cost was submitted for connecting Aransas Pass with Corpus Christi Bay, by a canal, and for protecting the head of Mustang Island from erosion. Estimated cost, $771,000.

No estimate for deepening the bar was submitted, the plans suggested being of questionable utility and involving very large expenditures. (See Appendix N 4.)

6. *Survey and examination at Buffalo Bayou, Texas*, for "a channel of navigation through Buffalo Bayou and Galveston Bay to Bolivar Channel, near the outer bar in the Gulf of Mexico." This survey was made by Lieutenant H. M. Adams, Corps of Engineers. (See Appendix N 5.)

7. *Examination to "ascertain the feasibility of opening a 12-foot channel to Dollar Point, on the west shore of Galveston Bay."*—This examination was made by Lieutenant H. M. Adams, Corps of Engineers. (See Appendix N 5.)

8. *Survey at the mouth of Trinity River, Texas.*—This was made in March and April, 1871, by Gustave Dyes, civil engineer, and a plan for improvement estimated to cost $40,000 was submitted by Captain Howell. The work would benefit a considerable interior trade. (See Appendix N 6.)

9. *Survey at the mouth of Sabine River, Texas.*—This was made in February and March, 1871, by Gustave Dyes, civil engineer.

A plan for improving the entrance to this river was submitted, the expense of which is estimated at $38,000. The work would benefit a considerable interior and coastwise trade. (See Appendix N 7.)

10. *Examination and survey of the bar at the entrance to the harbor of Brazos St. Jago, Texas.*—This survey was made in February, 1871, by Lieutenant H. M. Adams, Corps of Engineers. He estimates the cost of a jettee to effect radical improvement at $775,000, and this work must be extended into the Gulf from time to time. The amount of commerce to be benefited is reported to be small in comparison with the cost of improvement. (See Appendix N 8.)

Captain Howell was also charged with the following examinations and surveys under the third section of the act of March 3, 1871:

1. *At Galveston Harbor from the outer bar up to the Red-fish Bar, on or near to the west shore.*—Captain Howell submits his views upon the currents at the entrance to Galveston Bay and Harbor, and, in accordance therewith, proposes a general plan for the permanent improvement of these channels to admit vessels drawing 18 feet. (See Appendix N 1.)

2. *At Mississippi City, for a harbor on Mississippi Sound.*—This was made by Lieutenant H. M. Adams, Corps of Engineers, and an estimate submitted of the cost of a ship channel or canal six miles long, 200 feet wide, and 20 feet deep, leading from Mississippi City to the extensive harbor of Ship Island. (See Appendix N 9.)

3. *Examination and survey of Red River from the mouth to a point above the Raft, Louisiana.*—This will be made during the coming winter.

4. *Examination and survey of the Tangipahoa and Tchifuncte Rivers, in the State of Louisiana.*—This survey was made by Lieutenant E. A. Woodruff, Corps of Engineers.

The Tangipahoa River rises in Southern Mississippi, runs through Eastern Louisiana, and empties into Lake Pontchartrain. It passes through a finely timbered pine country, nearly parallel to and but a few miles from the New Orleans, Jackson, and Great Northern Railroad. It can be made navigable for steamers drawing but 4½ or 5 feet to Wells's Ferry, sixteen miles from its mouth. The estimated cost of so improving it is $5,400. The obstructions consist of snags, fallen and overhanging trees. The commerce of the stream is now inconsiderable, but would probably be greatly increased by the introduction of a line of small steamers, which would be rendered possible by the improvement.

5. *The Tchifunete*, is a small stream, rising in Eastern Louisiana, and emptying into Lake Pontchartrain. It is now navigable for steamers drawing 5½ feet to its junction with the Bogue Falaya, eleven and a half miles from its mouth; beyond this it is not navigable. Bogue Falaya is navigable from its mouth to the town of Covington, three and three-fourths miles, but for three miles of this distance is badly obstructed by wrecks, and at one point by a bar. The estimated cost of removing these is $16,800. A considerable interior trade centering at Covington would be benefited by this improvement. (See Appendix N 10.)

6. *Survey and examination of Atchafalaya Bay and Calcasieu Pass, Louisiana.*—Atchafalaya Bay.—The survey was made by Gustave Dyes, civil engineer. Private parties interested in the steamship route

between Brashear City, Louisiana, and Galveston, Texas, are cutting a straight channel 12 feet deep from the deep water at the mouth of the Atchafalaya River through Atchafalaya Bay to the Gulf. This channel is well located, and its completion is of present importance to the commerce of Texas.

A statement of the work already done and an estimate of the cost of the completed work are submitted. (See Appendix N 11.)

7. *Calcasieu Pass* is the outlet of Calcasieu Lake in Southwestern Louisiana, and the bar at its head is the only obstacle to prevent vessels drawing 5 feet from ascending to the town of Lake Charles, Louisiana, fifty miles from the Gulf of Mexico. Calcasieu River, Lake, and Pass constitute a natural outlet for the commerce of a considerable and productive portion of Louisiana, which will be greatly benefited by improvement of its navigation.

The estimated cost of improvement is $15,000, if it can be made in connection with improvements on Sabine and Trinity Rivers, Texas, for which estimates have been rendered; if not, the estimate will be $40,000. (See Appendix N 12.)

IMPROVEMENT OF THE HARBOR OF MOBILE—SURVEYS AND EXAMINATIONS OF RIVERS AND HARBORS IN ALABAMA AND WEST FLORIDA.

Officers in charge, the late Major C. B. Reese, Corps of Engineers, to September 22, 1870; Captain A. N. Damrell, Corps of Engineers, to December 12, 1870; since which Colonel J. H. Simpson, Corps of Engineers, with Captain Damrell under his immediate orders.

1. *Improvement of Mobile Harbor and Bay.*—Under the appropriation of $50,000 by the act of July 11, 1870, the contractor deepened Choctaw Pass to a depth of 11 feet and width of — feet, thus giving a free passage for vessels drawing 10½ feet at mean low water up the bay to the wharves of Mobile.

On the 3d of March, 1871, Congress appropriating $50,000 more for this work, a contract was made for continuing it. This will open Choctaw Pass to a width of 200 feet and depth of 13 feet, and do something toward improving the channel through Dog River Bar. The amount required to make this last channel 13 feet deep and 250 feet wide is estimated by Colonel Simpson, exclusive of last appropriation and of cost of removing the upper and lower line of war obstructions, at $629,315 52.

An act of the legislature of the State of Alabama, approved in 1869, created a commission for the improvement of the harbor and bay of Mobile, and directed the county commissioners to issue county bonds to be applied to that purpose. The commission during the year has been duly organized, and demand has been made upon the county commissioners for bonds to the extent of $200,000. This commission has co-operated with the United States engineer officer in charge of the improvement of the harbor and bay, and has removed the upper line of obstructions, making a clear passage-way 600 feet wide; it has also contracted for the removal of the lower line of obstructions, and the work is now in course of execution; this has left the entire appropriation, made by Congress at its last session, available for payment for dredging.

Amount appropriated by act of July 11, 1870	$50, 000 00
Amount appropriated by act of March 3, 1871	50, 000 00
Amount expended during fiscal year ending June 30, 1871.	20, 714 76

Amount available July 1, 1871	$79,285 24
Amount required for fiscal year ending June 30, 1873	100,000 00

(See Appendix O 1.)

EXAMINATIONS AND SURVEYS UNDER THE ACT OF JULY 11, 1870.

1. *Examination and survey of the Coosa River.*—The survey, begun in September, 1870, under the immediate charge of the late Mr. H. C. Fillebrown, was pushed forward with all dispatch up the river until December 29, 1870, when the work was closed for the season at the railroad-bridge of the Selma, Rome and Dalton Company, near Wilsonville, Alabama, by the high stage of water in the river, the winter-rains having already set in.

Mr. Fillebrown's preliminary report sets forth the practicability of the improvement of the river.

The survey was transferred in June last to the charge of Major Walter McFarland, and is still in progress. (See Appendixes O and O 3.)

2. *Examination of the Tombigbee River, Alabama.*—This was made by Mr. H. C. Fillebrown, civil engineer. He states in his report that the river is susceptible of improvement by the removal of logs, snags, and other obstructions, and Colonel Simpson recommends an appropriation of $21,500 for this purpose. (Appendixes O 4 and O 5.)

EXAMINATIONS AND SURVEYS UNDER THE ACT OF MARCH 3, 1871.

3. *Mouth of Apalachicola River, Florida.*—A survey has been carried across the bar at the mouth of the river to 11 feet of water. A preliminary examination has been made for the purpose of locating the best channel to be improved across the bulkhead, and other shoals in the eastern portion of St. George's Sound, to enable vessels to reach the city by the eastern pass between St. George's Island and Dog Island. A preliminary examination has also been made to determine the practicability and propriety of improving New Inlet, a new channel through St. George's Island, nearly south of Apalachicola, and almost in the prolongation of the natural channel across the bar at the mouth of the river. A report with maps and estimates is expected at an early day. (Appendix O 6.)

4. *Chattahoochee River, below Columbus, Georgia.*

5. *Choctawhatchie River, Florida.*

6. *At the mouth of the St. Mark's River, from Spanish Hole to St. Mark's, Florida.*

7. *At Tampa Bay, Florida.*

Examinations and surveys at these last four localities have been deferred until the more favorable season of autumn. Preparations have been made for their prosecution, and the results will be submitted as soon as received.

IMPROVEMENT OF THE HARBORS AND RIVERS ON THE ATLANTIC COAST SOUTH OF CAPE FEAR.

Officer in charge, Major Q. A. Gillmore, Corps of Engineers, who has Captain Ludlow, Corps of Engineers, under his immediate orders.

1. *Improvement of the ship-channel in Charleston Harbor.*—With the $13,000 appropriated by act of March 3, 1871, for this object, it is proposed during the present fiscal year to remove the several wrecks named and described below, viz:

1st. The Palmetto State, an iron-clad gunboat, sunk in the mouth of Town Creek, just above the city, in 1865.

2d. The Charleston and the Chicora, two wrecks which lie nearly together in Cooper River, below Drum Island, off Marshall's wharf.

3d. The Patapsco, a single-turreted monitor, sunk in the channel-way in 29 feet of water, near Fort Sumter.

4th. The Beatrice and her companion, two wrecks lying close together, (near the inner mouth of the Beach Channel,) abreast of Sullivan's Island, upon the north side of Drunken Dick Shoal.

For the further improvement of Charleston Harbor, the following sums are asked:

For removal of the wreck near Fort Sumter	$1,200
For removal of a portion of the Bowman jettee	8,000
For dredging in Beach Channel	10,000
For removal of wreck of the monitor Weehawken	12,000
For removal of wooden gunboat Housatonic	10,000
For removing hull of the monitor Patapsco	20,000
Total	61,200

2. *Obstructions in Town Creek, near Charleston, South Carolina.*—These obstructions, consisting of the wrecks of a torpedo-boat and a dry-dock, have been removed, so as to secure a continuous depth of 9 feet at mean low water over the positions which they occupied.

Amount appropriated by act of March 3, 1871	$7,500 00
Amount expended during the fiscal year ending June 30, 1871	4,654 26
Amount available July 1, 1871	2,845 74

3. *Improvement of the bar at the mouth of St. John's River, Florida.*—A contract was entered into for this work under conditions which promised success, by which the channel across the bar was to be deepened, and, by raking, dredging, or otherwise, maintained to a minimum depth of 10 feet at low water, and a width of 80 feet. An increased depth of from 1½ to 2 feet was several times attained; but, the appliances employed by the contractor being insufficient, the contract was finally annulled.

The officer in charge proposes during the present fiscal year to deepen this channel according to the following plan, viz:

To charter a suitable steamer for six months, and furnish her with a 9-inch centrifugal pump, two branches of 6-inch suction-hose, and a timber bin for holding the sand. The pump-engine to be connected with the steamer's boiler. The sand pumped from the bottom is to be discharged from the bin into deep water, either inside or outside the bar, as may be most expeditious.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	15,000 00
	30,000 00
Amount expended during the fiscal year ending June 30, 1871	334 07
Amount available July 1, 1871	29,665 93

EXAMINATIONS AND SURVEYS FOR IMPROVEMENTS.

1 *Savannah Harbor*, *Georgia*, in compliance with provisions of act of March 3, 1871.—The details of the wrecks, cribs, and shoals which constitute the obstructions of this harbor were carefully examined from above the city to Tybee Roads. The final report and recommendations have not yet been received, but a thorough examination and survey of Back River and Savannah River from the city to the junction with Back River is recommended, and an estimate of $5,000 for that purpose is submitted. The recommendation is concurred in.

2. *St. John's River*, *Florida, from the outer bar to Jacksonville*, (act of March 3, 1871.)—This work was not executed during the past fiscal year, but will be commenced early next December, and completed in time for the results to be submitted to Congress at its next session.

3. *Charleston Harbor*, provided for in section 2, act of July 11, 1870.—An examination of the various wrecks in the harbor was made, and a careful investigation was had to determine the best method of securing an improved channel of entry. This involved some hydrographic work, more particularly in the Beach Channel. (See Appendix P 1.)

IMPROVEMENT OF THE PATAPSCO BELOW BALTIMORE, OF THE SUSQUEHANNA BELOW HAVRE DE GRACE, AND OF THE POTOMAC BELOW GEORGETOWN; IMPROVEMENT OF RAPPAHANNOCK, JAMES, APPOMATTOX, ROANOKE, AND CAPE FEAR RIVERS, AND OF THE HARBORS OF QUEENSTOWN AND CAMBRIDGE, MARYLAND.

Officer in charge, Major W. P. Craighill, Corps of Engineers, who has under his immediate orders Captain C. B. Phillips, Corps of Engineers.

1. *Improvement of the entrance to the harbor of Baltimore in Patapsco River and Chesapeake Bay.*—(In charge of Colonel J. H. Simpson, Corps of Engineers, until November 6, 1870.)—Operations had been suspended for want of funds some time previous to the 1st of July, 1870. By the act approved July 11, 1870, an appropriation of $42,900 was made. The dredges and scows, the property of the United States, were repaired as soon as practicable, and were worked during the remainder of the season in the Brewerton and Craighill Channels. At the close of operations the machinery was sold, and a contract for dredging was made on the 20th April, 1871. Up to the close of the fiscal year dredging was limited to the Brewerton Channel, where it was most needed. In this work Captain J. H. Cooper, the port warden, actively co-operated with two of the dredges under his charge. A further appropriation of $50,000 was made March 3, 1871. Under a contract for additional dredging, the improvement of the entrance will be greatly advanced during the remainder of the working season and the spring of 1872. The entrance should have greater width and depth than the means now available will give. Range beacons are much needed, in order that the Craighill Channel can be fully utilized by night as well as by day.

Amount appropriated by act of July 11, 1870	$42,900 00
Amount appropriated by act of March 3, 1871	50,000 00
Amount received from sales of property	19,550 00
Amount expended during fiscal year ending June 30, 1871	20,453 30
Amount available July 1, 1871	92,010 58
Amount required for fiscal year ending June 30, 1873	200,000 00

(See Appendix Q 1.)

2. *Improvement of Susquehanna River, near Havre de Grace.*—(In charge of Colonel J. H. Simpson, Corps of Engineers, to November 7, 1870.)—An appropriation of $12,000 was made by the act of July 11, 1870. Under a contract with the American Dredging Company of Philadelphia, operations were begun September 20, 1870, in dredging a channel 100 feet wide and 10 feet deep at low water, extending from near Fishing Battery light to the mouth of the dredged channel. The material of the old movable deflector was applied during the working season of 1871 in the construction of a fixed wooden dike, to concentrate the flow of the water below the railroad-bridge, as had been proposed and practically accomplished by the temporary movable structure built several years ago. The new fixed deflector will be completed before November 1, 1871, to a length of about 3,500 feet. A permanent dike should be built on the line of the present wooden structure.

Expended in fiscal year ending June 30, 1871	$11,253 35
Available for fiscal year ending June 30, 1872	7,283 05
Required for fiscal year ending June 30, 1873	50,000 00

(See Appendix Q 2.)

3. *Improvement of Potomac River.*—(In charge, until November 10, 1870, of Major N. Michler, Corps of Engineers.)—An appropriation of $50,000 was made by the act of July 11, 1870, for the improvement of this river between the Long Bridge and Georgetown. After some delay a contract for dredging was made December 6, 1870, under which work has been continued in improving the Virginia or Georgetown Channel, giving it a width of 200 feet, and a depth of about 14 feet at mean low water. This channel will be completed during 1871. The location and extent of some dangerous rocks near Georgetown have been determined, whose speedy removal is very desirable. Nothing further now being required for the Virginia Channel, the propriety of improving the Washington Channel below Long Bridge deserves consideration, as well as of opening a channel from the Maryland draw of the Long Bridge to near Easby's Point.

Amount appropriated by act of July 11, 1870	$50,000 00
Amount expended in fiscal year ending June 30, 1871	26,568 54
Amount available July 1, 1871	23,431 46
Amount required for fiscal year ending June 30, 1873	160,000 00

(See Appendix Q 3.)

4. *Improvement of Rappahannock River, below Fredericksburgh.*—A report on the improvement of Rappahannock River was made January 26, 1871. This report indicated that the principal obstructions to navigation consisted of bars formed by alluvial deposits, and, in a few cases, the remains of wrecks sunk for military purposes during the war. An appropriation of $15,000 was made for this river by the act approved March 3, 1871. One wreck near Fredericksburgh has been removed. The dredging of a channel 8 feet deep at low-water, through the Spottswood and Fredericksburgh bars, has been commenced, and will be completed during 1871. Arrangements for the removal of several other wrecks from the river has been made, which is to be accomplished during the fiscal year ending June 30, 1872.

Amount appropriated by act of March 3, 1871	$15,000 00
Amount expended in fiscal year ending June 30, 1871	510 87

Amount available for fiscal year ending June 30, 1872....	$14,489 13
Amount required for fiscal year ending June 30, 1873......	75,000 00

(See Appendix Q 4.)

5. *Improvement of James River.*—A report on the improvement of James River was made October 31, 1870. An appropriation of $50,000 was made for this river by the act approved July 11, 1870. A further appropriation was made of $50,000 by the act approved March 3, 1871. The work done and proposed to be done with those appropriations is the following: Under contract Mr. B. Maillefert has removed the sunken vessels, &c., near Drury's Bluff, so as to give a clear channel-way not less than 250 feet in width and 18 feet in depth at low water. He has also removed, at Warwick, the wrecks of three schooners; at Grave-Yard Reach, the wrecks of the Gallego and Plume; below Aiken's some forty piles, the remains of an old bridge. Another contract has been made for other removals, as follows: At Drury's Bluff the remainder of the steamer Jamestown, the steamer Virginia, the steamer Fredericksburg, the steamer Beaufort, the schooner Wythe, the brig Marens, and parts of several remaining stone cribs. At Wilton, some forty or fifty piles, remains of an old bridge, and part of a steamer.

The work of opening the cut-off at Dutch Gap is very nearly completed, giving a depth of 18 feet at high water and a width of not less than 100 feet. The contractors are engaged in opening a channel through the rock at Rockett's Reef, giving a depth of 18 feet at high water and a width of 125 feet. The operations of the authorities of the city of Richmond have been confined chiefly to dredging at the worst shoals. Much will still remain to be done for the improvement of James River, as follows: The removal of rock in boulders and beds near the city, the excavation of sand and other material from the natural bars of the river and its deposit in suitable places; the construction of deflecting dikes, and the facings of spoil-banks; probably the excavation of cut-offs through Jones's Neck, and near Bermuda Hundred.

Amount appropriated by act of July 11, 1870............	$50,000 00
Amount appropriated by act of March 3, 1871...........	50,000 00
Amount expended in fiscal year ending June 30, 1871....	32,168 62
Amount available July 1, 1871, (all now under contract)..	67,831 38
Appropriation required for year ending June 30, 1873....	100,000 00

(See Appendix Q 5.)

6. *Improvement of Appomattox River below Petersburgh.*—Under the appropriation of the act of July 11, 1870, such examinations of this river as were necessary were made in August, 1870. It was then found that the city of Petersburg, through the agency of the Lower Appomattox Company, had appropriated $200,000 for the improvement of the river, according to a plan proposed by Mr. H. D. Bird. A board of engineers was organized to consider and report upon the improvement. (See Appendix —.) This board found a large amount of work already done according to Mr. Bird's plan, the adoption of much of which they deemed it expedient to recommend, for reasons which will be found stated in their report. In making recommendations for work to be done the board stated their object to be to lay down a plan as good as existing circumstances permitted, and such as, with the means likely to be furnished by the General Government and by the city of Petersburgh, would result in a decided improvement of the river. It was to give, as soon as practicable, chiefly by dredging, a channel 12

feet deep and 60 feet wide at ordinary high water, avoiding as much as possible abrupt bends or long, straight reaches, or regulating them where they could not be avoided, and never abandoning the actual navigable channel of the river without strong reasons. An appropriation of $50,000 was made by the act approved March 3, 1871.

The work of the city under Mr. Bird's plan having been considerably advanced since the report of the board of engineers in 1870, it was deemed expedient, the circumstances being changed, to depart somewhat from their recommendations as to details, while adhering to the general principles laid down by the board. Accordingly it has been decided to dredge in the south channel and to assist the city in completing the cut through Puddledock marsh. The existing appropriation will be applied to those two objects.

Amount appropriated by act of March 3, 1871	$50, 000 00
Amount expended in fiscal year ending June 30, 1871	706 30
Amount available for fiscal year ending June 30, 1872	49, 293 70
Amount required for fiscal year ending June 30, 1873	75, 000 00

(See Appendix Q 6.)

7. *Improvement of Roanoke River below Weldon.*—An appropriation of $20,000 was made for this river by the act approved March 3, 1871. The survey made in the preceding winter showed that the river needed improvement chiefly in the following particulars, viz: The removal of rocks below Weldon; of wrecks in the lower portion of the river; of shifting bars at several points between Weldon and the mouth, and of snags and overhanging trees at many places. It was determined to use the appropriation in removing the most troublesome wrecks and other obstructions, which were placed in the stream during the late war; in taking out some of the worst rocks near Weldon, and to apply the balance of the money to cutting off snags and overhanging trees. Proposals were received May 18, but were all rejected, as the prices were deemed too high. A contract on reasonable terms was, however, made under date of June 21, 1871, for removing a number of the most troublesome wrecks. Arrangements will be made for taking out during the coming winter some of the dangerous rocks near Weldon and cutting off some of the snags, &c. A special report on Roanoke River is in preparation.

Amount appropriated by act of March 3, 1871	$20, 000 00
Amount expended during the fiscal year ending June 30, 1871	220 75
Amount available for the fiscal year ending June 30, 1872	19, 779 25
Amount required for the fiscal year ending June 30, 1873	25, 000 00

(See Appendix Q 7.)

8. *Improving Cape Fear River below Wilmington, North Carolina.*—(In charge of Colonel J. H. Simpson, Corps of Engineers, until November 7, 1870.)—An appropriation of $100,000 was made for this river by the act approved July 11, 1870. After careful examination it was decided to adhere to the opinion of the commission appointed by the Secretary of War in 1858 to examine into the condition of the entrance to this river, that the closing of the inlets between Smith's Island and Zeke's Island was of the first importance. Accordingly work was commenced upon a line of cribs filled with stone and of such dimensions and strength as were deemed sufficient. The new work follows the line of the old breakwater in order to take advantage as much as possible of such portions

as yet remain. During the fiscal year the breakwater and its superstructure have been extended a length of 607 feet, which includes the most difficult and tedious portion, owing to the great depth of water and velocity of the current. Besides the construction of the breakwater, attention has been given to the maintenance of existing sand-hills and beaches, and the formation of new ones, by the use of cheap catch-sand fences, which have succeeded well. Shrubbery and other vegetation suited to the locality have also been planted and cultivated to advantage with the same object.

An additional appropriation of $75,000 was made for this improvement by the act approved March 3, 1871.

Amount appropriated by act of July 11, 1870	$100,000 00
Amount appropriated by act of March 3, 1871	75,000 00
Amount expended in fiscal year ending June 30, 1871	102,514 18
Amount available for fiscal year ending June 30, 1872	72,485 82
Amount required for fiscal year ending June 30, 1873	150,000 00

(See Appendix Q 8.)

9. *Improvement of Queenstown Harbor, Maryland.*—A survey of the harbor was made in November, 1870. The improvement needed was the dredging of a channel in Queenstown Creek, 100 feet wide at bottom and 8 feet deep at mean low water, at an estimated cost of $9,500. An appropriation of $5,000 was made by the act approved March 3, 1871. It was determined to expend this appropriation in making a channel 8 feet deep and as great a width as the funds would allow. After due advertisement for proposals, a contract was made dated April 26, 1871. The work was brought to a close July 27, 1871, the appropriation being exhausted. One cut, 25 feet in width, was made through of the proper depth, and a second cut of the same width and depth nearly through. If the amount of the original estimate had been appropriated in one sum, the work would have been completed.

Amount appropriated by act of March 3, 1871	$5,000 00
Amount expended during the fiscal year ending June 30, 1871	2,635 20
Amount available for expenditure in fiscal year ending June 30, 1872	2,364 80
Amount required to complete the work in year ending June 30, 1873	6,000 00

(See Appendix Q 9.)

10. *Improvement of the harbor of Cambridge, Maryland.*—A survey of this harbor was made in October, 1870. It was estimated that to give an entrance-way of 100 feet in width, and to provide sufficient harbor accommodations, of a depth of 10 feet at mean low water, would cost about $36,000. An appropriation of $10,000 was made by the act approved March 3, 1871. It was determined to expend this appropriation in dredging, providing as good an entrance and harbor, of the depth of 9 feet, as the funds would allow. After due advertisement a contract was made. A channel 100 feet in width to the mouth of the creek, and a channel 50 feet in width in the creek to the railroad-wharf, have been completed, and the remainder of the appropriation applied to the improvement of the exterior harbor and to the interior basin.

Amount appropriated by act of March 3, 1871	$10,000 00
Amount expended during the fiscal year ending June 30, 1871	2,474 57

Amount available for expenditure in year ending June 30, 1872	$7,525 43
Amount required to complete the work in year ending June 30, 1873	20,000 00

(See Appendix Q 10.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENTS.

In charge of Major Wm. P. Craighill, Corps of Engineers.

1. *Survey of Wicomico River, near Salisbury, Maryland.*—A resolution of the House of Representatives, dated February 3, 1871, directed a survey of this river, which was completed on the 15th of April, 1871. (See Appendix Q 12.)

2. *Examination and survey of the James River and Kanawha Canal.*—This survey was directed in the appropriation bill approved July 11, 1870. The field-work was begun as soon as practicable thereafter, two parties being organized and continued as late as the weather and funds permitted. To Mr. William R. Hutton was assigned the duty of ascertaining the best manner of continuing the communication by water, from the end of the old canal to the waters of the Ohio River. Mr. Walter Gwynn Turpin was placed in charge of the examination of the line of the canal from Richmond to Buchanan, with a view to a determination of the cost of its enlargement to a size which would adapt it to the extended use it would receive when it became a link in a great water-line of communication between the Atlantic slope and the valley of the Mississippi. A report, with estimates, was submitted under date of January 27, 1871. (See Appendix Q 13.)

3. *Survey of Accotink, Neabsco, Quantico, and Chappawamasic Bays, and of Aquia Creek.*—Directed in the appropriation bill of March 3, 1871. The field-work has been under the immediate supervision of Captain C. B. Phillips, Corps of Engineers, and was completed in July. The reports, maps, &c., will be completed and submitted at an early day.

4. *Survey of Norfolk Harbor and of Elizabeth and Nansemond Rivers.*—Directed in the appropriation bill of March 3, 1871. These surveys have been commenced. The field-work will be actively prosecuted during the remainder of the present season, and the reports and maps will be submitted before the close of 1871.

5. *Examination and survey of Roanoke River, in North Carolina.*—This survey was directed in the appropriation bill approved July 11, 1870. The lateness of the season and its unhealthiness caused a postponement of field-work until the occurrence of frost. A preliminary report was made, dated January 17, 1871. (See Appendix.)

An appropriation of $20,000 for the improvement of the river was made by the act approved March 3, 1871, the disposition of which is reported under the head of the improvement of Roanoke River. A report and map of this survey are in preparation, and will be soon finished.

6. *Survey of Neuse River below Goldsborough, North Carolina.*—This survey was directed in the appropriation bill approved March 3, 1871. Field-work was begun on the 18th of April, 1871, and completed in June. The preparation of the report and map is progressing. They will be soon completed.

7. *Survey of Cape Fear and Deep Rivers as far up as La Grange, North Carolina.*—Directed in the appropriation bill of March 3, 1871. The survey was begun at La Grange in June, 1871, and will be completed

by the end of September, 1871, when the preparation of the report and maps will be begun. They will be submitted by the end of the current calendar year, 1871. (See Appendix Q 11.)

8. *Survey and examination at Nag's Head, North Carolina, with a view to re-opening the old inlet near that place.*—This was made in compliance with the act of July 11, 1870, under the direction of Colonel J. H. Simpson, Corps of Engineers.

In the report submitted the different plans projected in 1820, 1829, 1840, and 1853, for opening an outlet to the sea, near Roanoke Island, are reviewed.

In 1852 an appropriation of $50,000 was made, and subsequently expended in an attempt to carry out the plan proposed in 1853, which required at its first step the excavation of a channel through Bodie's Island, opposite Roanoke Island; and in 1857, an engineer officer sent to inspect the work, finding the cut which had been made filled with drifting sand, reported unfavorably of the scheme, and recommended its abandonment, which was approved by the Secretary of War. The officer in charge of this examination also reports adversely to the practicability of re-opening any inlet in this vicinity. (See Appendix Q 14.)

CONSTRUCTION OF THE DELAWARE BREAKWATER AND OF THE PIER AT LEWES, DELAWARE; HARBOR IMPROVEMENTS ON DELAWARE RIVER AND BAY; IMPROVEMENT OF THE SCHUYLKILL, SOUTH, SALEM, AND SHREWSBURY RIVERS, NEW JERSEY.

Officer in charge Lieutenant Colonel J. D. Kurtz, Corps of Engineers, having under his immediate order Lieutenant M. R. Brown, Corps of Engineers.

1. *Delaware Breakwater.*—The works for the formation of this artificial harbor were completed last year in substantial accordance with the original project.

The commerce of the country has, however, increased much more rapidly than the provision here made for its accommodation, so that the harbor is found to be too small for its requirements. This is due principally to the fact that the sea from the northeast rolls into the harbor through the opening which exists between the principal work and the "ice-breaker," which lies to the north and west of it. This limits the protected area to the space lying in the immediate rear of the main work; whereas, if the sea should be shut out from this opening, the protected area would be increased three or four fold its present extent.

There are several ways of effecting this exclusion. Great caution should be exercised in determining which method should be followed, as an erroneous procedure would probably cause serious shoaling of the anchorage, and might also result in injury to the beach and shore-line of the harbor. The question will be referred to a board of experienced officers, from whose joint views respecting it a correct solution may be anticipated. The harbor now gives shelter to over fifteen thousand vessels in a year, whose commerce represents all parts of the country, and includes foreign as well as domestic ports.

The existing works at the Delaware Breakwater Harbor have cost	$2,127,403 00
Amount available July 1, 1871	3,673 10

(See Appendix R 1.)

2. *Construction of pier at Lewes, Delaware.*—Examinations to determine the character of the bottom of the harbor at Lewes, the direction

and force of currents, depth of water, and other particulars have been made, and a project for the proposed pier has been prepared and approved. Offers for the iron and lumber necessary for the structure have been received and accepted, and arrangements have been made for the conveyance to the United States by the State of Delaware of a site for the pier. The question of site for the structure was referred to a board of engineers familiar with the locality, and their recommendation was concurred in and adopted and the work commenced.

Amount appropriated July 15, 1870	$225,000 00
Amount expended during year ending June 30, 1871	3,992 50
Amount available July 1, 1871	221,007 50
Amount required for year ending June 30, 1873	55,000 00

(See Appendixes R 2, 3, 4, 5, and 6.)

3. *Harbor at Marcus Hook, Pennsylvania.*—Work on the ice-piers of the harbor at Marcus Hook has been completed. The piers are four in number, two on the upper and two on the lower end of the harbor. The space protected is about 600 feet by 250 feet.

The piers consist of a solid granite superstructure, above highest tides, on a basis of timber cribs filled with rough stone. The upper work is faced with granite ashler, securely dove-tailed and doweled together, the top being covered with large paving-flags, and each pier supplied with stone posts for vessels to moor to. The harbor will be of much service in the ice season as a place of refuge to vessels navigating the Delaware.

Amount available July 1, 1870	$50,781 43
Amount expended during year ending June 30, 1871	34,828 86
Amount available July 1, 1871	15,952 57

No further appropriation is asked for at present.

(See Appendix R 7.)

4. *Wilmington Harbor, Delaware.*—The appropriation of $15,000 made for this improvement is being applied to the deepening of the entrance from the Delaware, and of the river between Third street and Market street bridges.

The rock in mid-channel, a short distance above the Third street bridge, will be removed, and the channel at the entrance will be widened as much as the appropriation will allow.

The improvement of the river requires the removal of a small amount of soft material just below the mouth of the Brandywine; some additional cutting above the Third street bridge, with some widening of the channel, and a small bar cut away above Market street bridge.

There is another rock a short distance below the one which has been taken out; and below the Third street bridge a ledge projects into the channel from the south bank. These should be removed.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount expended during fiscal year ending June 30, 1871	2,739 44
Amount available July 1, 1871	12,260 56
Amount required for fiscal year ending June 30, 1873	15,000 00

(See Appendix R 8.)

5. *Repairing ice-harbor piers, at New Castle, Delaware.*—The small appropriation for this work has been applied to removing the decayed timber of the lower harbor-pier and replacing it by stone. One course of heavy stones, of two feet rise, has been laid around the pier, and the second course commenced.

The ice-harbor has been injured by encroachment of wharves and shoaling of the bottom. It is one of the original series of Delaware ice-harbors, and its maintenance is required by the commerce of that river.

To fit the harbor for usefulness for existing commerce requires the establishment of three new piers, at a probable cost of $20,000 each	$60,000 00
Completing repairs of existing pier	7,000 00
Total needed for Delaware ice-harbor at New Castle, for fiscal year ending June 30, 1873	67,000 00

Appropriation by act of July 15, 1870	$2,500 00
Amount expended during year ending June 30, 1871	2,449 05
Amount on hand July 1, 1871	50 95
Amount required for fiscal year ending June 30, 1873	67,000 00

(See Appendix R 9.)

6. *Clearing and buoying the channel of the Schuylkill River, Pennsylvania.*—The entrance to the Schuylkill River has been gradually increased in depth from 9 feet to 15 feet at low water, by natural causes, by the transit of vessels, and by the action of the commercial community interested in the navigation of the river.

The appropriation of $15,000 made by Congress for this improvement has been applied to further increasing this entrance channel to the depth of 18 feet, and to removal of other obstructions up the river, principally to cutting away a point just above Penrose's Bridge, which made it difficult for large vessels to pass the draw in that bridge.

The remainder of this appropriation, and the additional appropriation of $10,000 made at the last session of Congress, for this river, will be expended in cutting a passage through the shoals near Gibson's to the deep water above.

The commerce of the Schuylkill is rapidly increasing, and requires the employment of vessels of a large class.

This great and increasing commerce requires just accommodation. To afford this it is proposed to increase the depth of water at the mouth of the Schuylkill, and up to the petroleum-wharves, to 20 feet; above them to the shipping-points of marble, coal, iron, &c., to 18 feet.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Expenditures to June 30, 1871	15,096 75
Amount available July 1, 1871	9,903 25
Amount required for fiscal year ending June 30, 1873	40,000 00

(See Appendix R 10.)

7. *Ice-harbor at Reedy Island, Delaware River.*—In addition to the ice-harbors at Marcus Hook and New Castle, the commerce of the Delaware requires another at Reedy Island. This harbor was established in 1852, vessels having been accustomed to anchor on the east of this island

to avoid the running ice, but the appropriation was altogether inadequate to do the work, which was but little more than half completed, and o wood, which is fast decaying.

The upper line of piers inclosing this harbor requires to be rebuilt at once, and should be constructed of stone above low-water level. The lower line of wooden piers requires some repairs, and one or two additional piers, with stone superstructure, should be placed on this line to compensate for the shoaling which has occurred in the harbor, and to afford a better protected entrance to it; the estimated cost for which is $190,000. (See Appendix R 11.)

8. *Removal of obstructions of Salem River, New Jersey.*—An examination of this locality was made in October, 1870. The obstructions consist of rocky bars extending across the channel.

By the act of March 3, 1871, an appropriation of $4,000 was made for the removal of these obstructions, and a contract has been entered into for the execution of the work.

All rocks are to be cleared away to a depth of 9 feet below low water, from a channel-way 200 feet wide entirely across the bar.

No expenditures were made during the year.

Amount appropriated by act of March 3, 1871	$4,000 00

No further appropriation is needed at present for this work.

(See Appendixes R 12 and R 13.)

9. *Improvement of South River, New Jersey.*—Under the act of March 3, 1871, appropriating $15,000 for the improvement of this river, proposals were invited for doing the work of dredging, but through the failure of the lowest bidder to enter into contract the work has been delayed, and nothing was done in the fiscal year. The work is now, however, in reliable hands, with a just prospect of its being completed this season.

Appropriation by act of March 3, 1871	$15,000
Expended to June 30, 1871	
Amount available July 1, 1871	15,000

No further appropriation is now asked for this work.

(See Appendixes R 14 and R 15.)

10. *Improvement of the North and South Branches of the Shrewsbury River, New Jersey.*—Under the act of March 3, 1871, appropriating $14,000 for the improvement of this river, proposals were called for for doing the necessary dredging; but owing to the failure of the lowest bidder to enter into contract, the work has been delayed and nothing done in the fiscal year.

The work has since been awarded to a reliable party, and it is expected will be finished this season. The present appropriation will suffice to dredge the requisite channels through the shoal places in both branches of the river, and make the navigation of the river as perfect as practicable.

Appropriation by act of March 3, 1871	$14,000 00
Expended to June 30, 1871	197 50
Amount available July 1, 1871	13,802 50

No appropriation is asked for at present.

(See Appendixes R 16 and R 17.)

11. *Survey of Horse-Shoe Shoals, Delaware River, Pennsylvania.*—A preliminary examination of these shoals has been made, and much varied information relative thereto has been collected. A detailed survey is now in progress, the result of which will be plotted and compared with previous surveys of this part of the river. Such suggestions respecting the difficulty of the navigation and its improvement will then be made as the facts shall appear to warrant. (See Appendix R 18.)

12. *Examination of Chester Harbor, Delaware River, Pennsylvania,* in compliance with the act of July 11, 1870.—The report of this, together with a project for the improvement of the harbor, will be found in Appendix R 19.

13. *Delaware River between Trenton and Bordentown, New Jersey.*—The Delaware is navigable for 12 feet water at low tide as far up as Newbold's Island, a little below Bordentown, where, in passing from 12 feet in the south channel to a corresponding depth in the north channel, a ridge must be crossed, on which there are but 5 feet at low water. From this point 6 feet of water can be had at low water up to the bridge at Trenton, except at one point, Perriwig Island, three miles below the bridge, where a shoal about 800 yards in length must be passed over, having only 3 feet of water upon it. The commerce of the river requires a channel-way 200 feet wide to accommodate the tows of canal-boats, which have a breast of three or more boats, and must have room to pass each other.

For reasons given in this report, the officer in charge of the examination and survey recommends the improvement to be made on the eastern side of Perriwig Island, and estimates that it will require the removal of 140,000 cubic yards of gravel, boulders, &c., to make a cut through the shoal 200 feet wide and 6 feet deep at low water, which at 50 cents would be....................................$70,000 00
Below Newbold's Island, a cut 200 feet wide, 700 feet long, and 1 foot deep, will be required, which at 40 cents will be.. 2,000 00
Add for incidental expenses and contingencies............. 3,000 00

Total required.................................... 75,000 00

Of which sum $20,000 could be profitably expended in one season. (See Appendix R 19*a*.)

PHILADELPHIA AND CAMDEN BRIDGE.

The act of Congress of April 6, 1870, giving the consent of the United States to the erection of a bridge across the Delaware River between Philadelphia and Camden, required that the bridge-company, before commencing the construction, should submit to the Secretary of War such information concerning the plan and locality of the bridge as would enable him to determine whether the proposed structure would conform to the conditions of the act not to obstruct, impair, or injuriously modify the navigation of the river; and that the bridge should not be built until the Secretary of War approved the plan and location proposed. This subject was referred to a board of engineer officers, whose action and that of the Secretary of War thereon will be found in Appendixes R 20, 21, 22, 23, and 24.

IMPROVEMENT OF HUDSON RIVER AND REMOVAL OF OBSTRUCTIONS IN NEW YORK HARBOR.

Officer in charge, Lieutenant Colonel John Newton, Corps of Engineers, who has under his immediate orders Captain S. M. Mansfield, Corps of Engineers.

1. *Improvement of Hudson River.*—The following memorandum of work done in the fiscal year has been submitted by Colonel Newton:

New Baltimore Channel completed, 79,615 cubic yards of material dredged and removed.

Coeyman's Dike (State dike) repaired for a length of 120 feet, the expense of which was paid by the State commissioners.

Shore protection of Schodac Island, 227 linear feet constructed.

Overslaugh Rock, a portion removed by contract.

Bath Dike, 3,823 feet long, finished.

Patroon's Island Dike, 3,409 feet long, commenced and finished.

Old State dam, crossing this dike, removed.

Base Island Dike, 5,119 feet long, commenced and finished.

Some stone filling put into dikes.

Works to be finished during the present year: Dikes in the neighborhood of Coeyman's. A cut to be made through Fishhouse Shoal; through the Overslaugh Channel; and through the point of the middle ground near Coeyman's. Completing the filling of Base Island and Patroon's Island dikes with stone and leveling up with timber.

The amount of appropriation necessary to complete the improvement of Hudson River is $200,000.

The works of improvement have been so far successful, and the plans adopted should be completed in order to obtain the more perfect results anticipated in their design.

Amount appropriated by act of July 11, 1870	$40,000 00
Amount appropriated by act of March 3, 1871	40,000 00
	80,000 00
Amount expended during the year ending June 30, 1871	14,535 36
Amount available July 1, 1871	65,464 64
Amount required for the fiscal year ending June 30, 1873	90,000 00

(See Appendix S 1.)

2. *Removing obstructions in East River, including Hell Gate.*—Operations were resumed upon the excavation of the shaft, and tunnels were commenced in the latter portion of July, 1870. The shaft has been sunk from reference (21 feet) below mean low water to reference, (33 feet.)

The tunnels, ten in number, have been driven distances varying from 50 feet to 126 feet.

The first transverse gallery, 142 feet in length, was begun and finished, and 40 feet of the second gallery have been excavated.

The amount of rock removed was 8,306 cubic yards.

The work has hitherto been carried on by hand-drilling in the tunnels and galleries, and by hand-drilling and the Burleigh drills in the shaft. Preparations have been made for the early application of steam-drills to expedite the progress of the work.

Steam-drilling scow.—The operations of this machine have been applied to blasting upon Diamond and Coenties Reefs. Upon the former six rounds of blasts, covering the solid bed rock of the reef, have been exploded, and upon Coenties Reef four rounds have been fired.

The officer in charge asks for an appropriation of $450,000 for the fiscal year ending June 30, 1873, for continuing the operations in East River and at Hell Gate, including the commencement of operations for the removal of the middle reef, Hell Gate.

Amount appropriated by act of July 11, 1870	$250,000 00
Amount appropriated by act of March 3, 1871	250,000 00

Received from sales of property during the year	$775 97
Expended during the year ending June 30, 1871	176, 793 51
Amount available July 1, 1871	323, 982 46
Amount required fiscal year ending June 30, 1873	450, 000 00

(See Appendix S 2.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENTS.

Lieutenant Colonel Newton is charged with the following examinations and surveys directed to be made by the act of March 3, 1871:

1. At Otter Creek, Vermont.
2. At Passaic River, between Newark and Passaic, New Jersey.
3. At East Chester Creek or Inlet, New York.
4. At Port Chester Harbor, New York.
5. At Rondout Harbor, Hudson River, New York.

These are in progress, and the reports upon them when received will be duly submitted.

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF CONNECTICUT AND RHODE ISLAND, AND ON THE SOUTH SHORE OF LONG ISLAND SOUND.

Officer in charge, Major G. K. Warren, Corps of Engineers, who has Captain A. H. Holgate, Corps of Engineers, under his immediate orders.

1. *Improvement of Providence River, Rhode Island.*—During the past fiscal year 18,200 cubic yards of material have been removed from the channel, which is now 14 feet deep at mean low water for a width of 130 feet, 12 feet deep over a width of 200 feet, and 9 feet deep for a width of 350 feet up to Fox Point wharf. It is proposed hereafter to increase the width of the channel.

The following is the amount received and expended during the year:

Amount appropriated by act of July 11, 1870	$5, 000 00
Amount expended during the fiscal year ending June 30, 1871	5, 000 00
Amount available July 1, 1871	000 00
Amount required for fiscal year ending June 30, 1873	10, 000 00

(See Appendix T 1.)

2. *Removal of Bulkhead Rock, (Providence River, Rhode Island.)*—This rock had originally a depth of 8.9 feet, and so much of it has been removed during the year as to give 14 feet at mean low water. No appropriation is asked for the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$2,500 00
Amount expended during the fiscal year ending June 30, 1871	2,500 00

(See Appendix T 2.)

3. *Improvement of Pawtucket River, Rhode Island.*—The work upon this river during the last fiscal year has consisted in dredging, chiefly from Dunnell's wharf to the wharves in Pawtucket, a distance of about half a mile; 16,257 cubic yards have been excavated and the channel has been made 75 feet wide and 6 feet deep at mean low water.

Dredging is now being done between Dunnell's wharf and Spring Run at points where the channel has a less depth than 6 feet at mean low water.

Amount appropriated by act of July 11, 1870	$8,000 00
Amount appropriated by act of March 3, 1871	7,000 00
Amount expended during the fiscal year ending June 30, 1871	6,907 80
Amount available July 1, 1871	8,092 20
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix T 3.)

4. *Construction of Breakwater at Block Island, Rhode Island.*—During the year the substructure of the breakwater, for a length of 500 feet from the shore-line, was completed up to the level of mean low water. Work on the substructure is being continued, and a temporary harbor is being built; the latter is necessary to a successful prosecution of the harbor works, as there is now no landing-place for vessels employed on them.

Amount appropriated by act of July 11, 1870	$30,000 00
Amount appropriated by act of March 3, 1871	75,000 00
Amount expended during the fiscal year ending June 30, 1871.	22,313 50
Amount availiable July 1, 1871	82,686 50
Amount required for fiscal year ending June 30, 1873	267,000 00

(See Appendix T 4.)

5. *Survey and Improvement at Pawcatuck River, Rhode Island and Connecticut.*—A survey was made in the autumn of 1870, and an estimate for a channel 75 feet wide and 5 feet deep at low water was made. This improvement, at the price per yard at which the work is being done, will cost $26,833.

Amount appropriated by act of March 3, 1871	$10,000 00
Amount expended during the fiscal year ending June 30, 1871	159 15
Amount available July 1, 1871	9,840 85
Amount required for fiscal year ending June 30, 1873	17,000 00

(See Appendixes T 5 and T 6.)

6. *Improvement of Thames River, Connecticut.*—No work has been done on this river during the fiscal year. A contract has been made for dredging under appropriation made by act of March 3, 1871.

Amount appropriated by act of March 3, 1871	$10,000 00
Amount expended during the fiscal year ending July 1, 1871.	000 00
Amount available June 30, 1871	10,000 00
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix T 7.)

7. *Improvement of Connecticut River.*—The appropriation of $40,000, made by act of Congress of July 11, 1870, did not specify in what part of the river it was to be expended, but it was understood that $20,000 should be spent below Hartford and $20,000 above.

The improvement below Hartford consisted in dredging near Mouse Island, Pistol Point Bar, and at Pratt's Ferry Bar, and piling at Hartford Bar. The dredging was completed in the fiscal year. The time for completing the contract for the latter was extended, and the work is now going on.

The plan for the improvement above Hartford, which was completed in December, 1870, proposed wing-dams at five places between Hartford and Enfield Rapids, and these are now in process of construction. The improvement of the bar at the mouth of the river is a work of magnitude and difficulty, and a thorough survey must be made previous to the consideration of plans.

Amount appropriated by act of July 11, 1870	$40,000 00
Amount appropriated by act of March 3, 1871	35,000 00
Amount expended during the fiscal year ending June 30, 1871	22,170 72
Amount available July 1, 1871	52,829 28
Amount required for fiscal year ending June 30, 1873, for improvement and for survey of bar at mouth of river	23,000 00

(See Appendixes T 8, 9, and 10.)

8. *Improvement of Connecticut River above Hartford and below Holyoke.*—Owing to the diversity of opinion existing among the people interested in this improvement as to the manner and locality of expenditure of the money appropriated, a survey of Enfield Rapids is being made, the result of which, with the plan of the proposed improvement, will form the subject of a special report.

Amount appropriated by act of March 3, 1871	$20,000 00
Amount expended during the fiscal year ending June 30, 1871	607 43
Amount available July 1, 1871	19,392 57

(See Appendixes T 8, 9, and 10.)

9. *Improvement of New Haven Harbor, Connecticut.*—Under the appropriation of $15,000, made by act of Congress approved July 11, 1870, the removal of Middle Rock was commenced September 6, 1870, but the progress made not being satisfactory, the work was discontinued October 13, 1870.

A survey of the harbor was made in the spring of 1871. This survey showed that there were but 7½ feet of water in the channel, at mean low water, up to the wharves of the city.

It was decided to dredge a channel, giving 13 feet at mean low water, and to commence the removal of Luddington's Rock; both works are now in progress.

All of the available funds will be expended during the fiscal year. It is thought that no more dredging need now be done; but if the complete removal of the rocks obstructing the entrance to the harbor be decided upon, there should be $20,000 appropriated for work in the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	40,000 00
Amount expended during the fiscal year ending June 30, 1871	10,246 13
Amount available July 1, 1871	44,753 87
Amount required for the fiscal year ending June 30, 1873	20,000 00

(See Appendixes T 11 and T 12.)

Survey and improvement of Housatonic River, Connecticut.—A survey was made and the results reported January 23, 1871. The amount estimated as necessary for the improvement of the river, exclusive of the outer bar, was $24,886.

The amount appropriated by act of March 3, 1871, ($15,000,) is being expended by contract.

Amount required for the fiscal year ending June 30, 1873, $15,000. (See Appendixes T 13 and T 14.)

Survey and improvement of Bridgeport Harbor, Connecticut.—A full history of the survey and improvements heretofore made by the Government was given in report of January 12, 1871.

The least estimate for building a sea-wall, which is deemed absolutely necessary, and for dredging so as to give 14 feet of water at mean low tide, is $124,000.

The appropriation of $20,000 made by an act approved March 3, 1871, will be expended in dredging and in building a riprap wall, extending a short distance from the shore to test its effect in arresting the movement of sand and gravel along the beach.

The amount required for the fiscal year ending June 30, 1873, is $100,000. (See Appendixes T 15 and T 16.)

12. *Improvement of Westport Harbor, Connecticut.*—Under the appropriation of $2,500 made by act of Congress approved July 11, 1870, the sea-wall at Cedar Point was repaired at a cost of $1,913; the amount remaining on hand ($587) is too small to expend in any other manner than in making additional surveys. The dredging the canal and extending the sea-wall, the estimated cost is $30,000. (See Appendix T 17.)

13. *Survey and improvement of Port Jefferson Harbor, Long Island, New York.*—Report upon the survey of this harbor was made January 14, 1871. To secure a good entrance to this harbor will cost not less than $175,000. The harbor being land-locked, and of ample size, would become an important harbor of refuge for coasters if the entrance were improved. Under the appropriation of $15,000 made by act approved March 3, 1871, contracts for building a riprap sea-wall, and for dredging at the entrance have been made. The available funds will be expended during this fiscal year.

Amount required for fiscal year ending June 30, 1873, is $50,000. (See Appendixes T 18 and T 19.)

14. *Survey and improvement of Peconic River, Long Island, New York.*—A survey was made and the report was submitted in January, 1871.

The amount required to make a channel 75 feet wide, and 6 feet deep, at mean low water, was estimated to be $32,818 50. The amount appropriated by the act approved March 3, 1871, was $5,000. This amount is being expended in digging a channel as wide as can be done by an Osgood machine when dumping the material excavated on one side of the cut. Further appropriation should be made to widen this cut, and to convey the material away in scows.

Amount required for the fiscal year ending June 30, 1873, $28,000. (See Appendixes T 20 and T 21.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

1. *Examination at Narragansett Pier, Rhode Island.*—This examination, directed by the act of July 11, 1870, was made, and the report completed January, 1871. No appropriation was made by Congress. The estimate for a sea-wall and basin for the use of small steamers in ordinary weather was $12,326 24, but a very much larger amount is required to make a harbor suitable for all weathers. (See Appendixes T 22 and T 23.)

2. *Survey of Southport Harbor, Connecticut.*—Report of this survey was made January, 1871, in compliance with the act of July 11, 1870. A recommendation for an appropriation of $12,225 was made for repairing the sea-wall and riveting the dike. No appropriation was made by the last Congress. (See Appendix T 24.)

3. *Survey of Stonington Harbor, Connecticut.*—This survey has been made in compliance with the act of March 3, 1871. A report and plan

of improvement will be submitted during the coming winter. (See Appendix T 25.)

The surveys of *Norwalk Harbor*, *Connecticut*, and of *Huntington Harbor*, *Long Island*, *New York*, directed by the act of March 3, 1871, have been completed, but the final reports thereon have not yet been received.

SEA-WALLS AT GREAT BREWSTER, DEER, AND LOVEL'S ISLAND, BOSTON HARBOR.

Officer in charge, Colonel H. W. Benham, Corps of Engineers.

1. *Great Brewster.*—The sea-wall on this island is reported to be in good condition, and no further expenditure appears to be required for the present.

2. *Deer and Lovel's Island.*—The three sea-walls on Deer Island are also reported to be in good condition. The officer in charge renews his recommendation of last year, that a further protection be given to their foundations, particularly at "North Head." For this he estimates the sum of $18,000 is required.

Lovel's Island.—The wall at the east end of the south bluff, built in 1868, remains in good condition and continues to serve as a good protection to the bluff. But the abrasion on the west side of the island, adjacent to the old wall at Ram Head, still continues.

The officer in charge submits an estimate of $15,000 for continuing the sea-wall 400 feet, and for an apron-facing of stone for 750 feet to the southwest. (See Appendix U 1.)

IMPROVEMENT OF RIVERS AND HARBORS IN THE STATES OF MAINE, NEW HAMPSHIRE, AND MASSACHUSETTS.

Officer in charge of those in Maine and New Hampshire, Lieutenant Colonel George Thom, Corps of Engineers; in Massachusetts, Lieutenant Colonel John G. Foster, Corps of Engineers, to May 25, 1871; after which Lieutenant Colonel George Thom, Corps of Engineers, who has Lieutenant J. B. Quinn, Corps of Engineers, under his immediate orders.

1. *St. Croix River, above "the Ledge," Maine.*—For the improvement of this river it will be necessary to deepen its channel by the removal of slabs, edgings, and sawdust, which for 30 years and more have been accumulating in large quantities. The act of Congress approved March 2, 1867, by which $15,000 was appropriated for this work, contained a proviso requiring the co-operation of the Province of New Brunswick before operations should be commenced. This co-operation not having been obtained, the appropriation has reverted to the Treasury.

An appropriation of $50,000 on the part of the United States, with an equal amount on the part of the Province of New Brunswick, will be required to accomplish this work, of which amount one-half could be profitably expended during the next fiscal year. (See Appendix V 1.)

2. *Narraguagus River, Maine.*—The improvement contemplated for this river comprises the removal of several bars, ledges, and a large number of boulders, which obstruct its navigation, from its mouth up to the bridge at Cherryfield, a distance of about seven miles.

By act of March 3, 1871, the sum of $12,000 was appropriated for this work, which sum is deemed sufficient to remove all the boulders and ledges.

Up to the 30th of June, 1871, about 250 boulders (weighing altogether about 550 tons) had been removed from the bed of the river, at and above Small's Point, including one of about 80 tons at Cherryfield, and 30 others weighing from 3 to 15 tons each.

The *bars* referred to have been created, in a great degree, by a deposition of sawdust which is still being thrown into the river from the saw-mills at Cherryfield and above; and it would seem proper that the bars should not be removed until the throwing in of the sawdust be prevented by suitable State legislation.

Amount appropriated by act of March 3, 1871	$12,000 00
Amount expended during fiscal year ending June 30, 1871	1,904 39
Amount available July 1, 1871	10,095 61

(See Appendixes V 2 and V 3.)

3. *Sullivan River and Sullivan Falls, Maine.*—This river is navigable up to Franklin, Maine, being a distance of about nine and a half miles from its mouth; and the only obstructions to its navigation are Hatcher's Rock and Ledge in the "Falls," and the old bridge-piers about one mile above the Falls. The estimated cost of its improvement is as follows, viz:

1. Removal of Hatcher's Rock to a depth of 10 feet below mean low water	$30,450 00
2. Removal of a portion of the ledge	1,500 00
3. Removal of three bridge-piers, at $2,000 each	6,000 00
4. Iron spindles on Half Side Ledge and low-water lock, at $1,250 each	2,500 00
Contingencies	3,550 00
Total	$44,000 00
Appropriated by act of March 3, 1871	10,000 00

A contract was made for removing 270 cubic yards of Hatcher's Rock. On the 1st of August this contract was completed, and the appropriation was thereby exhausted. This work has already greatly improved the navigation of the "Falls," in giving an increased depth of 4 feet of water over Hatcher's Rock.

Amount appropriated March 3, 1871	$10,000 00
Amount expended during the fiscal year ending June 30, 1871	226 97
Amount available July 1, 1871, (which will be expended during the present working season)	9,773 03
Amount required for fiscal year ending June 30, 1873	$34,000 00

(See Appendixes V 4 and V 5.)

4. *Union River, Maine.*—The proposed works of improvement in this river consist in the removal of slabs, edgings, sawdust, and boulders between Ellsworth and Fullerton's Point, and of several ledges and large boulders at its mouth.

A contract was made for the sum of $12,000 for opening a channel 150 feet wide through these obstructions at and below Ellsworth; and on the 30th of June, 1871, it was opened to a width of about 100 feet, with a probability of the work being completed about the 1st of October. Numerous large boulders had also been removed from the channel at and above its mouth.

The amount on hand July 1, 1871, is deemed sufficient for completing all the contemplated improvements.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during fiscal year ending June 30, 1871	3,813 98
Amount available July 1, 1871	26,186 02

(See Appendix 6.)

5. *Penobscot River, Maine.*—This river is obstructed in its navigation by several bars and ledges at Bangor and below. These bars are for the most part composed of slabs, edgings, and sawdust, which have been thrown into the river for the last fifty years from the saw-mills at Bangor and above. The ledges obstructing it are in the channel at Bangor, and are known as "Independence Rock," "Steamboat Ledge," "Gulliver's Rock," &c.

In order to render the navigation of this river safe and practicable at all stages of the water, the officer in charge recommends that a channel be excavated down to the natural bed of the river above Low's Ledge, where it ranges in depth from 9 to 12 feet, and below Low's Ledge through the slabs and edgings to a depth of 12 feet, at low water in the lowest stages of the river.

The work done up to the 30th of June, 1871, consists in the excavation of portions of "Independence Rock" and "Steamboat Ledge," in all about 480 tons.

A contract was made for opening a channel to the contemplated depth and to a width of about 200 feet, through the obstructions in three localities where most necessary at and below Bangor. Work was commenced under this contract on the 19th of June.

Amount appropriated by act of July 11, 1870	$15,000 00
Amount appropriated by act of March 3, 1871	50,000 00
Amount expended during fiscal year ending June 30, 1871	7,559 37
Amount available July 1, 1871	57,440 63
Amount required for fiscal year ending June 30, 1873	50,000 00

(See Appendix 7.)

6. *Kennebec River, Maine.*—The plan in progress for the improvement of this river consists in straightening and deepening its channel by dredging through the several shoals and the removal of several ledges, and numerous boulders which obstruct it between Richmond and Augusta, Maine. The width of the channel is to be 100 feet, (the sides having a slope of 2 feet to 1 foot rise,) and a depth of seven feet up to Hallowell, and 6½ feet thence to Augusta, at low tide, in its lowest stages.

On the 30th of June, 1870, the channel had been opened to the required depth through Shepherd's Point Shoal, Hallowell Shoal, and Britt's Shoal, to a width of not less than 75 feet, and through Gage's Shoal (at Augusta) to an average width of 45 feet, and about 50 large boulders had been removed from the bed of the river.

During the fiscal year ending June 30, 1871, the following work has been done in the improvement of this river, viz: the channel through Gage's Shoal and Britt's Shoal has been increased and completed to the required width of 100 feet, and a depth of 6½ feet in the lowest stages of the river. A channel has been excavated through Hinckley's Shoal (between Gardiner and Hallowell) to a width of 100 feet and a depth of 7 feet in the lowest stage of the river, and work commenced under a contract for increasing to a width of 100 feet the channel heretofore dredged through Shepherd's Point Shoal and Hallowell Shoal, with a probability of its completion this autumn. About fifty large boulders have also been removed from the bed of the river. This will complete all the contemplated improvements above Gardiner, Maine, and no further appropriation is required therefor.

The appropriation of $5,000 made by act of March 3, 1871, for improving the river between Richmond and Gardiner is to be applied to the removal of the ledge near Nehumkeg Island, and to opening a channel 100 feet wide and 10 feet deep at low water through the upper sand bar, and proposals have been invited for doing the work by contract.

Amount on hand July 1, 1871	$668 84
Amount appropriated by act of July 11, 1870	15,000 00
Amount appropriated by act of March 3, 1871, (which includes $5,000 for improvement below Richmond and Gardiner)	15,000 00
Amount expended during fiscal year ending June 30, 1871	15,928 81
Amount avaliable July 1, 1871	14,740 03
Amount required for fiscal year ending June 30, 1873, (for improvement between Gardiner and Richmond)	8,000 00

(See Appendix V 8.)

7. *"Gut" near Bath, Maine.*—The amount expended has been applied to the removal of Boiler Rock to a depth of 10 feet, and Boiler Rock Ledge to a depth of 9 feet at mean low water, the removal of two wrecks (of about 100 and 200 tons respectively) from the main channel above the "Gut," dredging a channel through the bar above the "Gut" to a depth of 10 feet below mean low water and 100 feet in width, and to placing several buoys to mark the channels thus opened and improved. The balance on hand is deemed sufficient to complete all the work contemplated for the improvement of this place.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	6,500 00
Amount expended during fiscal year ending June 30, 1871	13,562 47
Amount available July 1, 1871	2,937 53

No further appropriation is required.

(See Appendix V 9.)

8. *Royals River, Maine.*—The navigation of this river is obstructed by bars and rocks between its mouth and Yarmouth.

The estimated amount required for making the contemplated improvement is $35,000; amount appropriated therefor by act of March 3, 1871, $10,000.

It having been decided to apply the amount appropriated to the opening of a channel through Gravel Point Bar, near Yarmouth, proposals were invited for the work, and a contract was made for commencing the work on or before the 1st of July and completing it on or before the 15th of November, 1871.

Amount appropriated by act of March 3, 1871	$10,000 00
Amount expended during fiscal year ending June 30, 1871	181 77
Amount available July 1, 1871	9,818 23
Amount required for fiscal year ending June 30, 1873	25,000 00

(See Appendix V 10 and V 11.)

9. *Portland Harbor, Maine.*—The progress made in the improvement of this harbor up to the 30th of June, 1870, consisted in the completion of the breakwater to an extent of 733½ linear feet; the excavation of a channel to a depth of 20 feet at mean low water, through the "spit

above and near middle ground," and in excavating a channel through the "Middle Ground Bar" to a depth of not less than 20 feet at mean low water, (or 29½ feet at mean high water,) and to an average width of 250 feet.

The amount expended during the year has been applied to the excavation of the channel through the "Middle Ground Bar," whereby it was opened to an average width of 300 feet.

To complete the contemplated improvements there remains the extension of the breakwater for about 190 linear feet, and the increase of the channel through the "Middle Ground Bar" to a width of 500 feet.

The additional amount required for the completion of these improvements is	$45,000 00
Amount on hand July 1, 1870	7,646 37
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	40,000 00
Amount expended during fiscal year ending June 30, 1871	17,997 29
Amount available July 1, 1871	39,649 08
Amount required for fiscal year ending June 30, 1873	45,000 00

(See Appendix V 12.)

10. *Saco River, Maine.*—The progress made in the improvement of the navigation of this river up to the 30th of June, 1870, consisted in the partial construction of the breakwater at its mouth for an extent of 4,200 feet out from the shore, and in the removal of all the sunken rocks from its channel near Little Islands.

The amount expended during the year has been applied to increasing the breakwater in height and thickness, about 8,000 tons having been added to it. About 4,000 tons more will be required to complete this work to its required height and thickness, which will be finished this year.

Additional amount required for completing all the proposed improvements in this river, $16,000, which amount could be profitably expended thereon during the next fiscal year.

Amount on hand July 1, 1870	$736 80
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during fiscal year ending June 30, 1871	13,825 88
Amount available July 1, 1871	11,910 92
Amount required during fiscal year ending June 30, 1873	16,000 00

(See Appendix V 13.)

11. *Kennebunk River, Maine.*—The work contemplated for the improvement of this river embraces the extension and repair of the stone piers at its mouth, and the repair of the Government wharf near its mouth.

The amount expended during the year has been applied to the completion, by contract, of the extension of the eastern pier for a length of 168 feet, and the partial repair of the wharf and old piers. A contract has also been made for the extension of the western pier, which will be completed this year.

The funds now available for the proposed improvements of this river will be sufficient for their completion.

Amount appropriated by act of July 11, 1870	$5,000 00
Amount appropriated by act of March 3, 1871	5,000 00

Amount expended during fiscal year ending June 30, 1871	$4,991 16
Amount available July 1, 1871	5,008 84

(See Appendix V 14.)

12. *Cocheco River, New Hampshire.*—The improvement of the navigation of this river consists in the excavation of a channel through the ledges, boulders, and bars, between the town of Dover and the "Lower Narrows," (which are about one mile below,) so as to have depth enough for vessels drawing 9 feet of water, at ordinary high water.

The sum of $10,000 appropriated by act of March 3, 1871, is applied to opening a channel through the "Lower Narrows" to a width of 75 feet, and a depth of 4 feet below mean low water; and to the removal of boulders above and below the "Lower Narrows."

A contract has been made for excavating the channel through the "Lower Narrows" for the sum of $7,000, to be completed on or before the 31st of October, 1871, and it is probable that it will be completed about the last of September.

Additional amount required for completing the proposed improvements of this river	$35,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during the fiscal year ending June 30, 1871	125 67
Amount available July 1, 1871	9,874 33
Amount required for fiscal year ending June 30, 1873	35,000 00

(See Appendixes V 15 and V 16.)

13. *Merrimac River, Massachusetts.*—The improvements originally contemplated for this river are as follows, viz:

1. The removal of obstructions at the Upper and Lower Falls, above Haverhill, Massachusetts;
2. The removal of Gangway Rocks and "The Boilers," in the harbor of Newburyport, Massachusetts; and
3. The removal of the wreck of a coal-vessel sunk at the mouth of the river, near Newburyport light.

The amount expended during the year was applied by General Foster to the removal of the wreck and Gangway Rock, and the partial removal of North Gangway Rock, all in Newburyport Harbor; also to the removal of about 475 cubic yards of material from the channel through the Lower Falls, above Haverhill, Massachusetts. By these operations the appropriation of July 11, 1870, was nearly exhausted.

Under the appropriation made by act of March 3, 1871, (which by the act is required to be applied to the improvements above Haverhill,) a contract has been made for excavating a channel through the Lower and Upper Falls, to the extent allowed by the appropriation now available.

The estimated cost of the work to be done for completing the improvements, as heretofore contemplated, in addition to the amount available July 1, 1871, is as follows, viz:

1st. For the removal of the ledges in the harbor of Newburyport, Massachusetts	$20,000 00
2d. Improving the Upper and Lower Falls, as heretofore contemplated	120,000 00
Total	140,000 00

Of this amount the sum of $45,000 could be profitably expended during the next fiscal year in the removal of the sunken ledges in the harbor of Newburyport, Massachusetts, and in the completion of the channel through the Lower Falls, above Haverhill, Massachusetts.

Amount appropriated by act of July 11, 1870	$25,000 00
Amount appropriated by act of March 3, 1871	25,000 00
Amount expended during the fiscal year ending June 30, 1871	24,996 34
Amount available July 1, 1871	25,003 66
Amount required for the fiscal year ending June 30, 1873	45,000 00

(See Appendix V 18.)

14. *Gloucester Harbor, Massachusetts.*—A survey of this harbor was made in the autumn of 1870, under the direction of Lieutenant Colonel John G. Foster, Corps of Engineers, from which it appears that there are several ledges which should be removed, the estimated cost of which is $10,000; and that a breakwater connecting Dog Bar and Round Shoals with the "Point," so as to afford a much-desired shelter for commerce, would probably cost about $500,000. For Colonel Foster's report see Appendix V 19.

15. *Boston Harbor, Massachusetts.*—The following works contemplated for the preservation and improvement of this harbor, remaining unfinished on the first of July, 1870, were, viz:

1. Sea-wall for the preservation and protection of Point Allerton.
2. Sea-wall for the protection and preservation of Gallop's Island.
3. Sea-wall for the protection and preservation of North Head of Long Island.
4. The removal of Kelley's Ledge.
5. Dredging the channel through the "Upper Middle Bar."

The progress made during the past year upon these works is as follows, viz:

1. Sea-wall on Point Allerton was commenced in September, 1870, and carried on under contract until the first of June, 1871, and by hired labor during the latter part of that month. The contemplated length of this wall is 1,230 linear feet. Of the wall proper, an average of about 440 linear feet was completed during the year, leaving to be completed about 790 linear feet of wall, together with a part of the back filling, all the granite paving, and the grading of the bluff in its rear.

2. *Sea-wall on Gallop's Island.*—Its construction by a contract was commenced in 1868 and continued in 1869 and 1870; and in October, 1870, the wall proper was completed—its total length being 1,745 feet. On the first of July, 1871, this work was all completed with the exception of about 1,136 superficial yards of granite paving and a greater part of the grading of the high bluff in its rear, with a probability of the completion early this autumn.

3. *Sea-wall on the North Head of Long Island.*—The construction of this work was commenced under contract, in August, 1870, and so continued until the 1st of June, 1871, and afterward by hired labor.

The length of this wall as projected is 2,100 feet. Of the wall proper an average of about 670 linear feet has been completed during the past year, leaving about 1,430 feet to be built, as well as all the granite paving and the greater part of the back filling and grading.

4. *Removal of Kelley's Ledge.*—The removal of this dangerous rock from the main ship-channel to a depth of 23 feet below mean low water was resumed and nearly completed in the latter part of 1870, leaving

only a few projecting points to be reduced. Altogether 834 tons were removed from the ledge.

5. *Dredging a channel through the "Upper Middle Bar."*—The projected improvement at this place consists in the excavation of a channel to a width of 1,000 feet, and a depth of 23 feet at mean low water. One "cut" 2,200 feet in length and 45 feet in width was made entirely through the bar during the past season; and some progress made in a second "cut."

Under the appropriation of March 3, 1871, proposals have been invited for continuing the sea-walls on Point Allerton and Long Island, as well as for dredging on the "Upper Middle Bar," and in the latter part of July, 1871, contracts were made for these works.

For the completion of all these works to the extent contemplated, it is estimated that there will be required the additional sum of $415,000, and that $175,000 could be profitably expended thereon during the next fiscal year.

(See Appendix V 20.)

A report from Lieutenant Colonel J. G. Foster, January 10, 1871, giving the plans adopted for the preservation and improvement of Boston Harbor, the progress made in their execution, the results expected and ascertained, and the conclusions he draws from them, will be found in Appendix V 21.

Amount on hand July 1, 1870	$74,619 32
Amount appropriated by act of July 11, 1870	100,000 00
Amount appropriated by act of March 3, 1871	100,000 00
Amount expended during fiscal year ending June 30, 1871	195,975 15
Amount available July 1, 1871	78,644 17
Amount required for fiscal year ending June 30, 1873	175,000 00

16. *Taunton River, Massachusetts.*—The navigation of this river is obstructed by several shoals and rocks between Dighton and Taunton, a distance of about five miles, the removal of which has proved to be difficult. It is intended to open a channel through them, which shall have 4½ feet of water at mean low water (or 9 feet at high water) for a width of 60 feet.

Proposals have been invited several times for this work, and a contract was finally made in March, 1871, for excavating the channel for $5 per cubic yard. Under this contract, work was commenced on the 7th of June, 1871, and it is to be completed on or before the 30th of June, 1872; but it is probable that it will be done before the 1st of December next.

Additional amount required to complete the contemplated improvements, $35,000, which amount could be profitably expended thereon during the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$10,000
Amount appropriated by act of March 3, 1871	10,000
Amount expended for fiscal year ending June 30, 1871	608
Amount available July 1, 1871	19,392
Amount required for fiscal year ending June 30, 1873	35,000

(See Appendix V 22.)

17. *Plymouth Harbor, Massachusetts.*—The plan recently adopted for the protection of this harbor consists in the construction of brush bulkheads and jettees, which are built of a frame-work filled with brush and

ballasted with stone. This work serves to check the motion of the waves and sand, and to form a new bank, which subsequently becomes enlarged and strengthened by the planting of beach-grass upon it. Thus far it has been attended with very satisfactory results wherever it has been adopted in this harbor.

During the past year, ending June 30, 1871, about 1,700 linear feet of bulkhead and jettees have been built, leaving about 600 feet more to be done. Some repairs have also been made on the old work where necessary. Contracts have also been made for completing the remainder of the bulkhead on or before the 30th of September, 1871, and for furnishing all the stone required for riprapping the beach out as far as the beacon, the same to be completed on or before the 10th of November, 1871. Operations were commenced and satisfactory progress was made under these contracts in the month of June.

The amount available will be sufficient to complete all the works now required and under contract, together with the probable repairs that may be necessary until the close of the fiscal year ending June 30, 1872. But in order to provide for repairing injuries which may at any time be caused by the violent storms to which the work is exposed, and which should be at once repaired, it is recommended by the engineer in charge that there be appropriated for that purpose the sum of $2,500 for the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	11,093 49
Amount available July 1, 1871	8,906 51
Amount required for fiscal year ending June 30, 1873	2,500 00

(See Appendix V 23.)

18. *Hyannis Harbor, Massachusetts.*—The work of rebuilding the breakwater has been carried on during the past year. Three hundred linear feet of the breakwater have been rebuilt, and 250 feet more contracted for, of which 175 feet of foundation have been rebuilt ready for the top wall; the whole 250 feet will probably be finished about the 1st of September, 1871, leaving but 225 linear feet yet to be done for the completion of the work. The cost of its completion, as estimated by the engineer in charge, will be $10,000, which amount could be profitably expended during the next fiscal year.

Amount appropriated by act of July 11, 1870	$12,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	12,096 50
Amount available July 1, 1871	9,903 50
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix V 24.)

19. *Provincetown Harbor, Massachusetts.*—The work carried on during the past year consists in the repairs where most needed of the bulkheads and jettees on Beach Point, and in the construction of a dike at Abel Hill, across the head of Lancey's Harbor.

The engineer now in charge of this work estimates that the sum of $10,000 will be required for the completion of the dike and for repair of the harbor-works during the next fiscal year.

Amount on hand July 1, 1870	$5,131 57
Amount appropriated by act of March 3, 1871	6,000 00

Amount expended during fiscal year ending June 30, 1871	$2,102 32
Amount available July 1, 1871	9,029 25
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix V 25.)

EXAMINATIONS AND SURVEYS FOR IMPROVEMENT.

Lieutenant Colonel Thom was charged with and completed the following examinations and surveys directed to be made by the second section of act of July 11, 1870:

1. Fifteen Mile Falls, New Hampshire.
2. Cocheco River, at Dover, New Hampshire.
3. Royals River, Maine.
4. Narragangus River, Maine.
5. Sullivan River, Maine.
6. Sullivan's Falls, Maine.

The reports of these examinations will be found in Appendix V.

The surveys of the following harbors and rivers are completed, and the reports thereon will be submitted at an early day:

1. At Wells Harbor, Maine, (act of March 3, 1871.)
2. Re-survey of Fifteen Mile Falls, New Hampshire, (act of March 3, 1871.)
3. Wellfleet Harbor, Massachusetts, (act of July 11, 1870.)
4. Duxbury Harbor, Massachusetts, (resolution of House of Representatives.)
5. Wareham Harbor, Massachusetts, (resolution of House of Representatives.)

HARBORS AND RIVERS ON THE PACIFIC COAST.

IMPROVEMENT OF RIVERS IN OREGON.

Officer in charge, Major R. S. Williamson, Corps of Engineers, to April 11, 1871; since that date, Major H. M. Robert, Corps of Engineers.

1. *Lower Willamette River, Oregon.*—Operations during the past fiscal year have been confined to dredging on Swan Island Bar. The season suitable for dredging is very short, being limited to the latter part of the summer, a portion of the autumn and of the spring. There remains yet a distance of 2,000 linear feet to be deepened to complete the channel to a depth of 17 feet at low water, which, it is expected, may be completed during the summer of 1872.

Access to this river has, within the last year, been rendered very difficult by the filling up of the channel across St. Helen's Bar, in the Columbia River, and of that through the bar at the mouth of the Willamette, which was deepened by dredging two years ago. The increasing foreign commerce of Portland, Oregon, needs the removal of these obstructions, many vessels grounding in the two rivers during the year, and all over 17 or 18 feet draught having to forward from one-third to one-half their cargoes by lighters for a distance of eighty or one hundred miles before they can ascend the river. The dredge-boat used on the work at present is one loaned to the United States by the city of Portland, and is not well fitted for the work, costing $3,000 for annual repairs. An appropriation of $50,000 for the construction and running expenses during one year of a steam-dredge and two scows for use on these rivers is earnestly recommended by the officer in charge.

Amount available July 1, 1870	$11,046 02
Amount appropriated by act of July 11, 1870	31,000 00
Amount expended during the fiscal year ending June 30, 1871	24,329 48
Amount available July 1, 1871	17,716 54
Amount required for fiscal year ending June 30, 1873	50,000 00

(See Appendixes W 1, 2, and 3.)

2. *Upper Willamette River, Oregon.*—A survey of this river above Oregon City was made last autumn by Lieutenant W. H. Heuer, Corps of Engineers.

The work to be done consists in scraping the bars with a Long's scraper, and in removing snags after the high-water season with a snag-boat built for the purpose. Wing-dams will also be built in several places. No estimate for funds required for the fiscal year 1872–'73 can be rendered until after the close of the present working season.

Amount appropriated by act of March 3, 1871, and available on July 1, 1871	$16,000 00

(See Appendixes W 1, 2, and 3.)

3. *Umpqua River.*—An examination of the rapids of this river was made by Major Williamson, Corps of Engineers, in the autumn of 1870.

Preparations have been made for blasting a channel through the most dangerous rapids, which will be carried on during the present fiscal year.

Amount appropriated by act of March 3, 1871, and available July 1, 1871	$22,500 00

No appropriation asked for the year ending June 30, 1873.

(See Appendixes W 1, 2, and 4.)

4. *Examination of the bar of the Sacramento River, California, known as the Hog's Back.*—This was made under the direction of Major Williamson, by Lieutenant W. H. Heuer, Corps of Engineers.

This bar consists of a number of shoals extending about three and one-half miles, having 7 to 8 feet depth of water, with deep water between them. The average width of the 7-foot channel over them is 200 feet, the narrowest width 75 feet. The least depth of 7 feet is at Eagle Nest Shoal, which is about 400 feet across.

Some attempts have been made to improve this navigation by dredging, but a rise in the river soon refilled the portion dredged, and it was found of no avail. Wing-dams have also been tried, and although the effect of those built by the California Steam Navigation Company has in some cases been beneficial, in others they have caused the formation of bars injurious to navigation. Major Williamson recommends an appropriation of $7,500 for the purpose of constructing a dam 500 feet long at Eagle Nest, and one of 700 feet near Suterville; and also for repairs of the old dam at Heacock's Shoals. To be effective, such works must be extended wherever the strength of the current is insufficient to prevent deposit.

(See Appendix W 5.)

5. *Examination and survey at Santa Cruz, California.*—Major Williamson reports that by an act of the legislature of California approved February 11, 1870, a commission was appointed "to examine the harbor of Santa Cruz and Salina Slough in the bay of Monterey for the purpose

of ascertaining whether the same, or either of them, are or can be made suitable for a harbor of refuge, and whether the same, or either of them, can by artificial means be improved." A copy of the report of this commission is transmitted. He reports "that to improve the harbor of Santa Cruz with a view of making it a harbor of refuge, a breakwater similar to the one described by the commission must be built; and the cost of such a structure will be several millions of dollars." The estimated cost of the breakwater proposed by the commission is $5,702,400. (See Appendix W 6.)

6. *Examination and survey for improvement at Eureka Harbor, California.*—As the officer to whom this survey and examination was intrusted reported that, from an experience of six or eight years and personal knowledge of the locality, he considered it impossible to make any permanent improvement of the bar at the entrance to Humboldt Bay or Eureka Harbor, the whole subject was referred to a board of engineer officers, Lieutenant Colonel B. S. Alexander, Lieutenant Colonel C. S. Stewart, and Major R. S. Williamson.

The communication of Major Williamson and the report of the board are transmitted herewith. From the latter it will be seen that the board is of opinion, "after mature consideration, that no permanent improvement of the entrance to this harbor is practicable."

Attention is invited to the suggestion of the board in reference to furnishing additional aids to navigation, such as buoys and range-lights, to facilitate access to and egress from the harbor.

(See Appendixes W 7 and W 8.)

REMOVAL OF BLOSSOM ROCK, HARBOR OF SAN FRANCISCO.

Officer in charge, Major R. S. Williamson, Corps of Engineers.

The act of June 23, 1866, directed a survey in the harbor of San Francisco with the view to the removal of both Blossom and Rincon Rocks. The work of removing the former having been successfully completed, it is recommended that an appropriation be made for the removal of Rincon Rock.

This rock is about 400 feet to the eastward of Rincon Point, and is believed to have an area, at a depth of 20 feet below mean low water, of 120 by 80 feet. From the experience gained in the removal of Blossom Rock, the officer in charge believes that the sum of $50,000 will be sufficient for its removal to the depth of 26 feet.

For a description of the operations for the removal of Blossom Rock see Appendix W 9.

BREAKWATER AT WILMINGTON, CALIFORNIA.

Officer in charge, Major G. H. Mendell, Corps of Engineers.

An examination of this locality was made by Major R. S. Williamson, Corps of Engineers, in 1868, with a view of preparing a project for the improvement of the harbor. (See Annual Report, from this office, of 1869, page 479.)

The act of March 3, 1871, appropriated $200,000 for the construction of a breakwater.

In the months of April and May a partial survey of Wilmington Harbor was made in order to the final preparation of the project for its improvement. This was submitted on the 15th June, and in part approved.

Under subsequent instructions about 1,400,000 feet of timber were purchased in open market. Advertisements have been issued for bids for the construction of about 3,700 feet of the breakwater, to be finished by 1st March, 1872.

Such further portion of the breakwater as the money available will construct will be undertaken before the expiration of the fiscal year.

Amount appropriated by act of March 3, 1871	$200,000 00
Amount expended during fiscal year ending June 30, 1871	889 55
Amount available July 1, 1871	199,110 45
Amount required for fiscal year ending June 30, 1873....	200,000 00

(See Appendix W 10 and W 11.)

WASHINGTON AQUEDUCT.

Officer in charge, Major N. Michler, Corps of Engineers, until the 15th of November, 1870, and since then Major George H. Elliot, Corps of Engineers.

The dam at Great Falls remains in excellent condition. During the low water of the last year the appropriation of $5,500 was applied to the removal of obstructions above the dam, consisting of low grassy islands, rocks and ledges.

The appropriation will be sufficient to accomplish the purpose designed, and the dam will retain and throw into the Aqueduct water sufficient for a large increase of population to the District; but before the full capacity of the conduit (nearly 100,000,000 gallons a day) can be attained, an extension of the dam to the Virginia shore will be requisite.

Cabin John Bridge.—The appropriation of $10,000 for completing coping and iron railing is not sufficient for both, and an iron railing is not suitable for this narrow, elevated structure. The roadway, which is much used, is only 14 feet wide, and is 90 feet above the center. The guard should be high and strong enough to prevent accidents. It is proposed to place the coping, and retain the balance appropriated, in the hope that Congress will grant an additional appropriation. There should be a masonary guard or parapet, and for economy one has been designed of brick, to be covered with stucco. This will not cost more than a heavy iron railing, and will be much more in keeping with the character of the bridge.

The tunnels on the line of the conduit remain in good condition, except that some rocks fell some years ago from the roof to the floor of tunnel No. 1, which is not lined, and they interfere somewhat with the waterway. There is an appropriation available for their removal, and this will be effected as soon as the reservoirs are finished so that the water can be drawn from the conduit.

The conduit has needed no repairs during the year, except the filling of some slight cracks caused by the unequal character of the foundation.

The Dalecarlia tunnel, which was being lined with brick work at the date of the last annual report, was completed soon after, and the water has since been carried around the receiving reservoir, avoiding the occasional turbid water of the latter.

The receiving reservoir.—The balance of the appropriation available for this reservoir will be expended in constructing wing-walls at the mouth of the conduit, and should any money still remain, it will be applied to facing the water-face of the dam. Surveys have been made of the lands which were authorized to be set apart for the use of the Reform School under an act of Congress of the 6th May, 1870.

The distributing reservoir.—Contracts have been made for the slope-walls and houses of the water-gates of this reservoir, and good progress has been made. The appropriations available are sufficient for the completion of the works designed at this point.

The high-service reservoir in Georgetown.—A contract has been made for the construction and erection of an ornamental iron cornice on the domical arch covering the reservoir. The appropriation is sufficient for it and an iron fence around the reservoir grounds, which is included in the contract.

Purchases of lands.—All the lands for whose purchase and accrued rents Congress has made appropriations have been acquired during the year, excepting a portion of the land used for the roadway near Great Falls. The price demanded by the owners for the latter was thought unreasonable, and the balance of the appropriation was allowed to revert to the Treasury.

The new main from the distributing reservoir to Capitol Hill.—Appropriation was not made for this by the District legislature until July 20, 1871, when the invitations to bidders for the 9,000,000 pounds of iron pipe required to complete the line to New Jersey avenue were at once issued. The lowest bid was informal, though it was apparently made in good faith, and the contract was claimed under it by the bidders. The Attorney General of the United States having decided that the bid could not be received, and the difference between the lowest and the next lowest bid being $25,000, all bids were rejected, and proposals were again invited. This has caused some delay, (of about a month,) which is regretted, as it was hoped to have an increased supply of water before the meeting of Congress. In the contract to be executed there will be a heavy penalty for delay in the completion of the delivery at the time specified, viz, the 1st of February, 1872. Invitations for laying the pipe will be issued in a few days, and this, by the terms of the contract, must be completed within thirty days after all the pipes are received.

The funds on hand are sufficient for completing the Aqueduct, except as follows:

Estimate of the amounts required for the next fiscal year.

For dwellings for keepers of the water-gates	$5,000 00
For completing the parapets of Cabin John and the other bridges on the line of the conduit	10,000 00
For a telegraph connecting the Great Falls of the Potomac with the reservoirs and with the office in Washington	3,000 00
For maintenance (including salaries of the gate-keepers) and general repairs	12,000 00
Appropriated for the fiscal year ending July 1, 1871	120,822 00
Expended during the year	65,383 33
Remaining on hand 1st July, 1871	55,438 67

(See Appendix X 1.)

IMPROVEMENT AND CARE OF PUBLIC BUILDINGS AND GROUNDS IN THE DISTRICT OF COLUMBIA.

Officer in charge, Major N. Michler, Corps of Engineers, to June 1, 1871, since which time Major O. E. Babcock, Corps of Engineers.

For the condition of the public buildings and the several Government reservations, and for recommendations for the continuation of their above and near middle ground," and in excavating a channel through the "Middle Ground Bar" to a depth of not less than 20 feet at mean low water, (or 29½ feet at mean high water,) and to an average width of 250 feet.

The amount expended during the year has been applied to the excavation of the channel through the "Middle Ground Bar," whereby it was opened to an average width of 300 feet.

To complete the contemplated improvements there remains the extension of the breakwater for about 190 linear feet, and the increase of the channel through the "Middle Ground Bar" to a width of 500 feet.

The additional amount required for the completion of these improvements is	$45,000 00
Amount on hand July 1, 1870	7,646 37
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	40,000 00
Amount expended during fiscal year ending June 30, 1871	17,997 29
Amount available July 1, 1871	39,649 08
Amount required for fiscal year ending June 30, 1873	45,000 00

(See Appendix V 12.)

10. *Saco River, Maine.*—The progress made in the improvement of the navigation of this river up to the 30th of June, 1870, consisted in the partial construction of the breakwater at its mouth for an extent of 4,200 feet out from the shore, and in the removal of all the sunken rocks from its channel near Little Islands.

The amount expended during the year has been applied to increasing the breakwater in height and thickness, about 8,000 tons having been added to it. About 4,000 tons more will be required to complete this work to its required height and thickness, which will be finished this year.

Additional amount required for completing all the proposed improvements in this river, $16,000, which amount could be profitably expended thereon during the next fiscal year.

Amount on hand July 1, 1870	$736 80
Amount appropriated by act of July 11, 1870	10,000 00
Amount appropriated by act of March 3, 1871	15,000 00
Amount expended during fiscal year ending June 30, 1871	13,825 88
Amount available July 1, 1871	11,910 92
Amount required during fiscal year ending June 30, 1873	16,000 00

(See Appendix V 13.)

11. *Kennebunk River, Maine.*—The work contemplated for the improvement of this river embraces the extension and repair of the stone piers at its mouth, and the repair of the Government wharf near its mouth.

The amount expended during the year has been applied to the completion, by contract, of the extension of the eastern pier for a length of 168 feet, and the partial repair of the wharf and old piers. A contract has also been made for the extension of the western pier, which will be completed this year.

The funds now available for the proposed improvements of this river will be sufficient for their completion.

Amount appropriated by act of July 11, 1870	$5,000 00
Amount appropriated by act of March 3, 1871	5,000 00

A reconnaissance has been made, and stations erected for a triangulation, to connect Green Bay with Milwaukee, over a distance of one hundred and twenty miles, and a part of the angles measured.

Lines determined by azimuth and latitude are in progress down the two shores of the lake. The triangulation hydrography and topography of Lake St. Clair have been completed.

A reconnaissance has been made, and nearly all the stations erected for a triangulation, reaching from the forty-fifth parallel (the northern boundary of New York) to the east end of Lake Ontario, and a part of the angles have been measured. The topography and hydrography have been carried from the forty-fifth parallel to ten miles above (southwest) Ogdensburgh.

In Lake Champlain surveys of Plattsburgh and Burlington Bays have been made, and the narrows have been surveyed for a distance of thirteen miles from the south end of the lake.

In the office, besides the ordinary computation and plotting of the field-work, final chart No. 2 of Lake Superior, and a chart of Isle Royale, have been prepared for the engraver, and preliminary chart No. 3, of Lake Superior, has been engraved on stone and published. Final charts Nos. 1 and 3 of Lake Superior, and final chart of St. Clair are now in progress.

The expansions of the 15-foot brass bar, and of the two base-tubes, have been determined; observations for difference of longitude have been made with Du Luth, Minnesota; Washington, D. C.; Austin and Battle Mountain, Nevada; and Fort Leavenworth, Kansas. The Washington work has been reduced.

The meteorological work of the survey has been continued.

Amount of appropriation available for fiscal year ending June 30, 1872, all of which will be expended by that date,	$175,000 00
Amount required for fiscal year ending June 30, 1873—St. Lawrence and Lake Ontario, $75,000; Lake Michigan, $60,000; Lake Superior, $30,000; office and miscellaneous, $36,850	201,850 00

Estimate of funds to be appropriated for the survey of the northern and northwestern lakes for the fiscal year ending June 30, 1873.

St. Lawrence River and Lake Ontario.—To continue the triangulation, topography, and hydrography, one steamer, one triangulation and three shore parties, to reduce the work and construct the maps	$75,000 00
Lake Michigan.—To complete the shore-line hydrography and continue triangulation, to reduce the work and construct the maps, one steamer, three astronomical and two shore parties	60,000 00
Lake Superior.—To complete the triangulation, connecting it with that of Green Bay; to remeasure Keweenaw base; to construct the final maps, one steamer, three triangulation parties	30,000 00
Miscellaneous.—Meteorological observations and reductions, $6,000; transportation of parties, quarters, and fuel for officers, $4,500; office-rent, fuel, stationery, and instruments, $5,000; contingencies, 10 per cent., $18,350	36,850 00
Total	201,850 00

(See Appendix Y.)

Of this amount the sum of $45,000 could be profitably expended during the next fiscal year in the removal of the sunken ledges in the harbor of Newburyport, Massachusetts, and in the completion of the channel through the Lower Falls, above Haverhill, Massachusetts.

Amount appropriated by act of July 11, 1870	$25,000 00
Amount appropriated by act of March 3, 1871	25,000 00
Amount expended during the fiscal year ending June 30, 1871	24,996 34
Amount available July 1, 1871	25,003 66
Amount required for the fiscal year ending June 30, 1873	45,000 00

(See Appendix V 18.)

14. *Gloucester Harbor*, *Massachusetts.*—A survey of this harbor was made in the autumn of 1870, under the direction of Lieutenant Colonel John G. Foster, Corps of Engineers, from which it appears that there are several ledges which should be removed, the estimated cost of which is $10,000; and that a breakwater connecting Dog Bar and Round Shoals with the "Point," so as to afford a much-desired shelter for commerce, would probably cost about $500,000. For Colonel Foster's report see Appendix V 19.

15. *Boston Harbor*, *Massachusetts.*—The following works contemplated for the preservation and improvement of this harbor, remaining unfinished on the first of July, 1870, were, viz:

1. Sea-wall for the preservation and protection of Point Allerton.
2. Sea-wall for the protection and preservation of Gallop's Island.
3. Sea-wall for the protection and preservation of North Head of Long Island.
4. The removal of Kelley's Ledge.
5. Dredging the channel through the "Upper Middle Bar."

The progress made during the past year upon these works is as follows, viz:

1. Sea-wall on Point Allerton was commenced in September, 1870, and carried on under contract until the first of June, 1871, and by hired labor during the latter part of that month. The contemplated length of this wall is 1,230 linear feet. Of the wall proper, an average of about 440 linear feet was completed during the year, leaving to be completed about 790 linear feet of wall, together with a part of the back filling, all the granite paving, and the grading of the bluff in its rear.

2. *Sea-wall on Gallop's Island.*—Its construction by a contract was commenced in 1868 and continued in 1869 and 1870; and in October, 1870, the wall proper was completed—its total length being 1,745 feet. On the first of July, 1871, this work was all completed with the exception of about 1,136 superficial yards of granite paving and a greater part of the grading of the high bluff in its rear, with a probability of the completion early this autumn.

3. *Sea-wall on the North Head of Long Island.*—The construction of this work was commenced under contract, in August, 1870, and so continued until the 1st of June, 1871, and afterward by hired labor.

The length of this wall as projected is 2,100 feet. Of the wall proper an average of about 670 linear feet has been completed during the past year, leaving about 1,430 feet to be built, as well as all the granite paving and the greater part of the back filling and grading.

4. *Removal of Kelley's Ledge.*—The removal of this dangerous rock from the main ship-channel to a depth of 23 feet below mean low water was resumed and nearly completed in the latter part of 1870, leaving

only a few projecting points to be reduced. Altogether 834 tons were removed from the ledge.

5. *Dredging a channel through the "Upper Middle Bar."*—The projected improvement at this place consists in the excavation of a channel to a width of 1,000 feet, and a depth of 23 feet at mean low water. One "cut" 2,200 feet in length and 45 feet in width was made entirely through the bar during the past season; and some progress made in a second "cut."

Under the appropriation of March 3, 1871, proposals have been invited for continuing the sea-walls on Point Allerton and Long Island, as well as for dredging on the "Upper Middle Bar," and in the latter part of July, 1871, contracts were made for these works.

For the completion of all these works to the extent contemplated, it is estimated that there will be required the additional sum of $415,000, and that $175,000 could be profitably expended thereon during the next fiscal year.

(See Appendix V 20.)

A report from Lieutenant Colonel J. G. Foster, January 10, 1871, giving the plans adopted for the preservation and improvement of Boston Harbor, the progress made in their execution, the results expected and ascertained, and the conclusions he draws from them, will be found in Appendix V 21.

Amount on hand July 1, 1870	$74,619 32
Amount appropriated by act of July 11, 1870	100,000 00
Amount appropriated by act of March 3, 1871	100,000 00
Amount expended during fiscal year ending June 30, 1871	195,975 15
Amount available July 1, 1871	78,644 17
Amount required for fiscal year ending June 30, 1873	175,000 00

16. *Taunton River, Massachusetts.*—The navigation of this river is obstructed by several shoals and rocks between Dighton and Taunton, a distance of about five miles, the removal of which has proved to be difficult. It is intended to open a channel through them, which shall have 4½ feet of water at mean low water (or 9 feet at high water) for a width of 60 feet.

Proposals have been invited several times for this work, and a contract was finally made in March, 1871, for excavating the channel for $5 per cubic yard. Under this contract, work was commenced on the 7th of June, 1871, and it is to be completed on or before the 30th of June, 1872; but it is probable that it will be done before the 1st of December next.

Additional amount required to complete the contemplated improvements, $35,000, which amount could be profitably expended thereon during the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$10,000
Amount appropriated by act of March 3, 1871	10,000
Amount expended for fiscal year ending June 30, 1871	608
Amount available July 1, 1871	19,392
Amount required for fiscal year ending June 30, 1873	35,000

(See Appendix V 22.)

17. *Plymouth Harbor, Massachusetts.*—The plan recently adopted for the protection of this harbor consists in the construction of brush bulkheads and jettees, which are built of a frame-work filled with brush and

ballasted with stone. This work serves to check the motion of the waves and sand, and to form a new bank, which subsequently becomes enlarged and strengthened by the planting of beach-grass upon it. Thus far it has been attended with very satisfactory results wherever it has been adopted in this harbor.

During the past year, ending June 30, 1871, about 1,700 linear feet of bulkhead and jettees have been built, leaving about 600 feet more to be done. Some repairs have also been made on the old work where necessary. Contracts have also been made for completing the remainder of the bulkhead on or before the 30th of September, 1871, and for furnishing all the stone required for riprapping the beach out as far as the beacon, the same to be completed on or before the 10th of November, 1871. Operations were commenced and satisfactory progress was made under these contracts in the month of June.

The amount available will be sufficient to complete all the works now required and under contract, together with the probable repairs that may be necessary until the close of the fiscal year ending June 30, 1872. But in order to provide for repairing injuries which may at any time be caused by the violent storms to which the work is exposed, and which should be at once repaired, it is recommended by the engineer in charge that there be appropriated for that purpose the sum of $2,500 for the fiscal year ending June 30, 1873.

Amount appropriated by act of July 11, 1870	$10,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	11,093 49
Amount available July 1, 1871	8,906 51
Amount required for fiscal year ending June 30, 1873	2,500 00

(See Appendix V 23.)

18. *Hyannis Harbor, Massachusetts.*—The work of rebuilding the breakwater has been carried on during the past year. Three hundred linear feet of the breakwater have been rebuilt, and 250 feet more contracted for, of which 175 feet of foundation have been rebuilt ready for the top wall; the whole 250 feet will probably be finished about the 1st of September, 1871, leaving but 225 linear feet yet to be done for the completion of the work. The cost of its completion, as estimated by the engineer in charge, will be $10,000, which amount could be profitably expended during the next fiscal year.

Amount appropriated by act of July 11, 1870	$12,000 00
Amount appropriated by act of March 3, 1871	10,000 00
Amount expended during fiscal year ending June 30, 1871	12,096 50
Amount available July 1, 1871	9,903 50
Amount required for fiscal year ending June 30, 1873	10,000 00

(See Appendix V 24.)

19. *Provincetown Harbor, Massachusetts.*—The work carried on during the past year consists in the repairs where most needed of the bulkheads and jettees on Beach Point, and in the construction of a dike at Abel Hill, across the head of Lancey's Harbor.

The engineer now in charge of this work estimates that the sum of $10,000 will be required for the completion of the dike and for repair of the harbor-works during the next fiscal year.

Amount on hand July 1, 1870	$5,131 57
Amount appropriated by act of March 3, 1871	6,000 00

FOURTH AND FIFTH DIVISIONS.—*Property accounts, estimates, funds, survey of lakes, explorations, maps, instruments, &c.*, Major J. B. Wheeler.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brig. General, Chief of Engineers, commanding Corps of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., November 2, 1871.

SIR: I beg leave to transmit herewith a report received this day from Major N. Michler, Corps of Engineers, late in charge of public buildings and grounds in this District, of the public works under his direction during the fiscal year ending June 30, 1871.

This report should have been transmitted to this office in time to be submitted in my annual report of the 20th ultimo, but it may still be attached thereto as an appendix.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP, *Secretary of War.*

(Appendix X 3.)

APPENDIX.

APPENDIX A 1.

Annual report of Major D. C. Houston, Corps of Engineers, for the year ending June 30, 1871.

IMPROVEMENT OF DU LUTH HARBOR, MINNESOTA.

An appropriation of $60,000 having been made for the improvement of Du Luth Harbor, I was directed to apply this sum to the extension of the breakwater already built by the railroad company in the lake at that place. In pursuance of instructions I advertised for proposals for this work, and on the 24th of June, 1871, made a contract with Munger & Gray to extend the breakwater 500 feet. It is proposed to put in ten cribs, 50 by 30 feet, this season, leaving the superstructure above water till next spring. The amount appropriated will build the extension and repair the breakwater built by the railroad. This work is unusually exposed, and is liable to serious injury from the effects of large masses of ice, which are hurled against it during storms. The most secure protection of the work is now in process of formation by the action of the lake; the drift of shingle along the lake is arrested by the breakwater, and is now forming a beach of clean gravel extending over 100 feet from the shore line above water. This is constantly forming, and will, in time, form an effectual protection of the work. Minnesota Point, which separates Lake Superior from the Bay of Superior, is composed of the same material for a distance of nearly two miles from the north shore of the lake, and is believed to have been formed in the same way. It is proposed, however, to protect this work by a sheathing of oak timber placed vertically and bolted to the superstructure. These timbers to be 10 inches square, and placed 3 feet apart from center to center, to be about 8 feet in length. It is also proposed to raise the superstructure to 6 feet above water, and deck it over with plank or timber.

It is proposed to make this breakwater 3,000 feet in length, including the present work, which is 400 feet in length. The present appropriation will extend it 500 feet at least, leaving 2,100 feet to be built. The city of Du Luth is now engaged in cutting a canal through Minnesota Point, to connect the lake with the bay. Very little dredging, and of an easy nature, is necessary to make a splendid harbor at the upper end of the bay. This work is now being carried on with the consent of the Government, upon the condition that the city construct a dike, which shall prevent the waters of the St. Louis River from being diverted through the canal to the possible injury of the harbor of Superior City, Wisconsin, now being improved at large cost by the Government. With the completion of the canal, and the excavation of the bay, Du Luth will be abundantly supplied with harbor accommodations, and the extension of the breakwater further than is necessary to protect the docks now existing seems unnecessary. The extension now in progress will be sufficient to protect present improvements on the lake shore. Should future appropriations be made for this harbor, there will be a question as to their proper application, if the canal project is carried into effect.

A 2.

IMPROVEMENT OF SUPERIOR CITY HARBOR, WISCONSIN.

During the year the Minnesota pier has been extended 768 feet, and the Wisconsin pier 96 feet, up to 1 foot above water-level. The Minnesota pier now extends entirely across the old channel, and the effect has been to throw the current over to the line of the Wisconsin pier, where is now the deepest water. Vessels drawing 9 feet can now enter the harbor by the new channel. No dredging has yet been done between the piers, and it is believed that none will be necessary after the piers are extended across the bar, as the current will be sufficiently strong to scour out the channel to the necessary depth. Work is now progressing rapidly at this harbor. Both piers are being extended under separate contracts. It is anticipated that by the close of the season both piers will be extended up to water level over the bar, and to a depth of 12 feet. The current will then be so confined and directed as to force it in the desired channel. It is estimated that the sum of $65,000 will complete the extension of these piers to a depth of 18 feet, in accordance with previous estimates.

A 3.

IMPROVEMENT OF ONTONAGON HARBOR, MICHIGAN, LAKE SUPERIOR.

An appropriation of $10,000 having been made for this work by the act of July 11, 1870, a contract was made with James Mercer, of Ontonagon, to extend the west pier. At the date of this report the pier has been extended 160 feet. A further extension of 64 feet will exhaust the appropriation. The completion of this improvement, in accordance with plans heretofore submitted, requires a large sum, over $200,000. At the last session of Congress no appropriation was made. The local business of Ontonagan is now so small that additional harbor facilities are not necessary for its accommodation. The harbor is important as a harbor of refuge, though not now available for vessels of the largest class. In view of the increasing commerce of Lake Superior, I would recommend that this work be continued.

A 4.

IMPROVEMENT OF EAGLE HARBOR, MICHIGAN, LAKE SUPERIOR.

No work has been done at this harbor during the year. A contract was made with Richard Dunbar, of Washington, D. C., in December, 1870, to remove a portion of the rock now obstructing the entrance to the harbor. Work was to commence on the 1st of May, 1871. The contractor has failed to do anything whatever, and the work has been suspended to await the results of the operations of removing rock obstructions in Hell Gate, East River, New York.

A 5.

IMPROVEMENT OF MARQUETTE HARBOR, MICHIGAN.

The work during the year has been the extension of the breakwater. Four cribs—three, 50 feet by 30 feet by 26 feet, and one 50 feet by 30 feet by 27 feet—built up to water surface, have been added, and superstructure complete has been built over four of the six cribs reported in last annual report as sunk in place, but without superstructure, thus making a total of 200 lineal feet of superstructure built, and 200 lineal feet of addition to length of breakwater, which stands 1,210 lineal feet in length, 910 lineal feet of which is covered with superstructure, and complete. The work has progressed without interruptions, and as rapidly as was anticipated. The bottom continues hard and level, and the cribs vary in position but slightly after being sunk in place, a slight riprapping on both sides being found effective in holding them. The whole work stands in excellent condition. It is proposed, under the contract with Mr. James Coldwell, of Fulton, Oswego county, New York, bearing date September 23, 1870, and expiring November 1, 1871, to add an extension of 150 lineal feet, three cribs, building superstructure over the 300 lineal feet now up to water surface only; and, under the contract with Mr. Sidney Adams, of Marquette, bearing date of May 29, 1871, and expiring July 1, 1872, an extension of 500 lineal feet, ten cribs complete.

Both of these extensions will be completed during the year, giving a breakwater 1,860 feet in length, and complete, extending out into 30 feet depth of water. The shelter afforded within by this breakwater is now marked, and the effect of each crib added in extension is decided. The original estimate for this breakwater was $385,129 58, and the length designed was 2,050 feet; $197,000 has been appropriated, leaving $188,129 58 to make up the original estimate.

The funds already appropriated will complete 1,850 feet of the breakwater, leaving only 200 feet to be put in, according to the original plan. This portion of the breakwater being in a depth of about 30 feet, will require to be made wider than the present work, and it is proposed to make the cribs 35 feet wide. I estimate that it will require $45,000 to complete this extension, including the necessary riprapping and covering for the work, pier-head, &c. This would leave $138,129 58 of the original estimate. I would respectfully recommend that the work be extended, in order to afford the necessary protection to the wharves of the city, to the amount of the estimate. The importance of Marquette, as a harbor of refuge and shipping port for iron ore, is constantly increasing, and all expenditures looking to its greater security are well applied. For this reason I have estimated the sum of $100,000 for the year ending June 30, 1872.

A 6.

IMPROVEMENT OF MENOMONEE HARBOR, MICHIGAN.

The appropriation of the present year, $25,000, is the first money given for harbor purposes at this point. An examination of the locality was made last March, to ascertain what changes, if any, had taken place since the detailed survey was made, and upon the results of this, a project was framed and approved of, contemplating the building of a pile-pier, extending out in a northeasterly direction, to the waters of Green Bay, reaching 15 feet water, on a line somewhat south of the mid-line of the water-way of the mouth of the river, the construction commencing at a point about abreast of the center of the point of sand forming the north shore of the embouchûre, this pier to constitute the permanent work of improvement for the harbor, and to be extended inwards, or connected with the south bank of the river, subsequently, according as experience or the rights of the mill and property owners of the south shore might call for. To carry out this plan, a contract was made with Abner Kirby, of Chicago, Illinois, on the 19th of June, 1871, to construct, by December 1, 1871, 1,000 feet, or as much more as will exhaust the present appropriation, of such pile-pier 14 feet wide. Work was begun on June 30, and is now being energetically prosecuted. It is expected to have 1,000 feet of pier completed during present working season.

A 7.

IMPROVEMENT OF GREEN BAY HARBOR, WISCONSIN.

The operations during the year have been those of dredging, constructing a revetment of close-piling work, on west side of channel cut through "Grassy Island;" extending similarly, revetment on east side of same channel 85 feet, to the north, and riprapping the north shore of this Grassy Island on either side of the above revetment.

The dredging last working season consisted in cutting to the projected 200 feet width, and straightening the channel, inside or south of Grassy Island, toward the mouth proper of the Fox River, within the lines originally laid down for this harbor; work being begun on August 9, 1870, dredge and appliances being hired at the same rates as those of last fiscal year, viz, $120 per diem, ten working hours; dredging was also done outside of Grassy Island, for a distance of about 2,000 feet, towards Point au Sable, cutting a channel 14 feet deep by 100 feet wide on east side. During the present working season, the dredging has been that of leveling off and removing lumps from bottom, over area cut last season south of Grassy Island. A channel 200 feet wide by 14 feet deep now exists from the island to the first angle in the channel-line, about three fourths of a mile in length. From this point it is proposed to continue this dredging to the mouth of the river, as far as it was projected to carry it, giving the same width and depth, though with no heavy cutting. A considerable amount of dredging is yet required to accomplish this. It is also proposed to widen the channel north of the island 60 feet on west side, cutting 14 feet depth; this to be dredged during present season.

The revetment to channel through island on west side is 700 feet in length, even with that on east side, which was extended for this purpose 85 feet to the north; these works consist of close-piling back now open, filled in with stone and brush, and answers effectively the end in view; the work is in good condition, save some repairs on back side of east revetment, at its head, due to damage done by ice, which will be made at once. The riprapping extends 450 feet on the east side, and 280 feet on the west side of the island, 18 inches above water, and has been most effective in preventing the water breaking through the island, and filling in with sand the dredged channel inside. Some strengthening of it was found necessary the present spring, which has been done. A careful survey, made from the ice last February, disclosed the same results as the one of the preceding winter, that the channel dredged remained intact.

A 8.

IMPROVEMENT OF AHNEPEE HARBOR, WISCONSIN.

The appropriation of the present year, $25,000, is the first allotment of funds for the purpose of harbor improvements at this point. Based upon the survey of 1870, a project was devised and approved of for the construction, as an initiatory measure, of a pile protection-pier. To carry out this project a contract was entered into on May 31, 1871, with Messrs. Roberts and Johnson, of Carlton, Kewanee County, Wisconsin, to construct by December 1 proximo, 600 feet—or as much more as will exhaust the funds now available—of such a pier. Owing to divers delays on the part of the contractors, work was not begun until June 30, two weeks later than was contemplated; it is now in progress and proceeding fairly. It is proposed to construct the 600 feet during the present working season.

A 9.

IMPROVEMENT OF TWO-RIVERS HARBOR, WISCONSIN.

The appropriation of the present year, $25,000, is the first one Congress has made for harbor improvements at this place. An extended survey of the locality having been made last year, and the results reported to the chief engineer, a project was formed and approved of, for constructing at the mouth two parallel pile protection piers, as a preparatory step to further and more extensive improvements, these piers to be 260 feet apart. In accordance with this plan, a contract was entered into on June 15 with R. A. Conolly, of Chicago, Illinois, to construct such a pile-pier, 400 feet in length, on the east side of the mouth, and one of 400 feet, or as much more as will exhaust the present appropriation, on the west side, by December 1 proximo. Both piers will run out and cross the outer bar, the main obstruction to a use of the interior waters, ending in 6 feet of water. As yet the contractor has not begun operations; it is expected and believed, however, that he will have completed piers above estimated for, during the present working season.

A 10.

IMPROVEMENT OF MANITOWOC HARBOR, WISCONSIN.

The money appropriated by Congress in 1869 having been expended, work at this harbor was necessarily suspended until the necessary forms of advertising and awarding contracts had been complied with for the disposal of funds made available under the act of appropriation of date July 11, 1870. On the 2d of September, 1870, a contract was entered into with Mr. David Smoke, of Manitowoc, the former contractor, with the United States Government, for the construction of 224 running feet of pier extension, more or less, and as he had most of the materials on hand which were necessary, he was enabled to fulfill the requirements of his contract before the close of November, 1870. The sinking and filling of seven cribs, four on the north and three on the south side of the channel, each 32 feet in length by 20 feet in width, to the water-surface, was comprised in this extension. These cribs, together with the crib sunk by Mr. Smoke on the 25th of June, 1870, under a previous contract, and included in report of June 30, 1870, were left during the winter, and to the present time without superstructure.

The alignment of the piers at this harbor is excellent, as far as finished with superstructure, as is also the general character of the work. The cribs sunk last year have settled somewhat out of position, owing to a change in the character of the material forming the lake-bed under this portion of the piers; no serious difficulty, however, is apprehended in overcoming the effect of the tilt given to the cribs from this cause, as the upper timbers at the greatest displacement of the cribs are not thrown more than 2½ feet out of alignment. A contract was made with the Government on the 15th day of June, 1871, by Mr. R. A. Conolly, of Chicago, for the construction of an additional extension of 96 running feet of pier-work, both on the north and south sides of the channel, forming together 192 running feet. Under the same contract he is to build the superstructure over the eight cribs above mentioned.

The harbor inside the piers has been greatly improved by the citizens of Manitowoc during the past year. Substantial docks have been built on both sides of the river, in order to meet the requirements of the increasing trade of the place; and further improvements of the same character are being made as fast as the demands of commerce require them. A dry-dock is in course of construction, and is expected to be finished so as to receive vessels during the present season of navigation. About thirteen miles of the railroad between Manitowoc and Appleton is graded, and the requisite quantity of iron for that length of road has been delivered. A dredge has been kept at work constantly in the river by the city authorities, and a uniform depth of about 11 feet of water attained for a distance of nearly a mile from the extremities (eastern) of the piers.

Two first-class lake steamers, and four schooners, have been built at this harbor, and four steamers and fifteen sailing-vessels have been repaired during the year.

Upon the completion of the present contract, the piers will be extended so as to have 14 feet of water at the entrance to the harbor, and no farther extension is at present required.

A 11.

IMPROVEMENT OF SHEBOYGAN HARBOR, WISCONSIN.

During the month of July, 1870, the superstructure was completed as far as desirable over the four cribs which remained in position, out of the six cribs which were built by S. M. Barrett under contract of date June 23, 1869, the details relating to which were stated in report of June 30, 1870. On the 3d of September, 1870, a contract was made with Mr. F. M. Knapp, of Racine, Wisconsin, for the construction of 192 running feet, more or less, of pier extension. Owing to the difficulty of procuring the necessary materials so late in the season, the work was not commenced until May of this year. The contractor has placed and filled a crib over the original position of crib known as No. 6; and built and placed a super-crib over broken crib No. 5, together forming a length of

64 running feet built to the water-surface in extension of the south pier. This has been done under contract of September 3, 1870, and Mr. Knapp will also extend the north pier 192 running feet under the same contract. Bids were received and opened on the 1st day of June, 1871, for a further extension of the piers; 128 running feet is to be constructed on the north side of the channel in extension of the pier, and the same length to be built in addition to the south pier, forming together, under this contract, 256 running feet of pier work. Mr. F. M. Knapp was again the successful bidder, and a contract was entered into by him to do this additional work on the 17th day of June, 1871. It is expected that the whole of the work under these contracts, equal in length to 448 running feet of pier extension, will be completed to the water-surface before the 1st day of December of the present year. The loose character of the sand forming the lake bed at this point renders the sinking, settling, and retaining of cribs in their proper positions extremely difficult. The piers at this harbor should each be finished by placing a crib at each extremity of dimensions 50 feet in length by 30 feet in width. The stone has settled to a serious extent for the whole length of the piers, and the cribs should be refilled. It would take about five hundred cords of this material to fill them up to a proper height.

The pier-work which was built by the county and Government prior to 1860 is in a dilapidated condition.

The channel also between the piers is not as deep as it should be to meet the requirements of the increasing trade of the place. The cost of these additional improvements would be approximately as follows:

For 2 cribs, each 50 feet long, by 30 feet wide, at $5,000	$10, 000
For 500 cords of stone ballast, at $8	4, 000
For 5,000 cubic yards of dredging, at 30 cents, (to make channel a uniform depth of 14 feet water)	1, 500
For repairing 600 running feet of old pier, at $16	9, 600
For contingencies	2, 900
	28, 000

A 12.

IMPROVEMENT OF PORT WASHINGTON HARBOR, WISCONSIN.

In the bill passed by Congress July 11, 1870, appropriating funds for the improvements of harbors, an allotment of $15, 000 was made to the harbor of Port Washington for that purpose. As an inducement to the Government to make such an appropriation it was stated that an equal sum would be raised by the town of Port Washington, to assist the Government in the enterprise. In order to assess the people legally, it was necessary to obtain authority through action of the State legislature. That body not being in session at the time the funds w required, the sum of $4,000 was raised by a subscription of the citizens of the town. Work was commenced on the 5th day of September, by dredging a channel from the navigable waters of Lake Michigan to the shore, and across the bar into the channel bed of Sauk River. A portion of the proposed inside basin, 600 feet in length, 50 feet in width, and of an average depth of 6 feet, was excavated by the dredge. A part of the material excavated was thrown out on the bank, the remainder was carried by scows to the deep water of the lake and there deposited. The character of the material forming the lake and river bed at this point is excessively hard, being an indurated clay of a reddish gray color, mixed with gravel and small boulder deposit. Such a foundation for crib piers is much more suitable than the loose sand which is the general character of the deposit at the mouths of the rivers discharging into Lake Michigan. The bank which was thrown out by the dredge when working from the navigable water to the shore retained its form for some time after the excavation, notwithstanding it experienced quite heavy weather, and advantage was taken by the merchants of the place to ship grain and receive supplies by means of small craft as long as the channel thus dredged remained open, thereby effecting quite a saving of the heavy expense for dockage and warehouse charges to which they have heretofore been subjected. The money raised by the citizens of Port Washington was devoted last fall to the purchase and driving of piles and leveling off the material which was thrown out on the north side of the basin. The number of piles thus purchased and driven by them was four hundred and thirty, forming a length of 460 running feet of dock front; $10,000, minus the sum paid for piling, &c., last year, has been legally voted by the county for the improvement of the harbor this season to be appropriated to dredging. The dredging above described was done under an agreement made by the Government with Albert Conro, of date September 1, 1870, in accordance with which he was paid at the rate of $150 per diem; ten hours of actual work of the dredging-machine, tug-boat, and two dump-scows to constitute one day's labor. For the dredging-machine and scows payment was made at the rate of $125 per diem of ten hours' work; for the use of tug-boat $25 per diem of ten hours' work.

The following is an account of the expenditure made by the Government for dredge, tug, and scow hire, with the materials purchased for the protection of the basin from freshets during the winter and spring months:

For 48 days' work of tug-boat, at $25 per diem	$1,200 00
For 57.67 days' work of dredging-machine, and 2 dump-scows, at $125 per diem	7,083 75
For 12 cords of stone, at $3 50 per cord	42 00
For 74 cords of brush, at $2 per cord	149 00
Total expenditure by the Government for labor and materials	8,474 75

It is proposed to construct crib-piers from the shore running outward into the lake, as far as the funds available will admit during the present season.

An agreement was made with Mr. Albert Conro, of Milwaukee, on the 12th day of June, 1871, under which he is to build, place, sink, and fill with stone ten cribs each 64 feet in length by 14 feet in width; five of which are to be placed on the north side, and five on the south side of the proposed channel leading to the basin. The extremities of these piers will reach the curve-line of 6 feet of water.

Mr. Conro has made an agreement with the citizens of Port Washington to do the necessary dredging for setting the cribs in a depth of not less than 9 feet of water, and to the clay bed; $50,000 additional to the funds available will be required to carry out the piers to the required distance in the lake, as follows, viz:

For 14 cribs, each 64 feet by 20 feet by 17½ feet, at $3,000 each	$42,000 00
For 2 cribs, each 30 feet by 30 feet by 18 feet, at $2,500 each	5,000 00
For contingencies	3,000 00
	50,000 00

A 13.

IMPROVEMENT OF MILWAUKEE HARBOR, WISCONSIN.

With the exception of a few repairs, no work has been done at this harbor during the past fiscal year. On the 21st day of September, 1870, a contract was let to Messrs. Hasbrouck & Conro of this city, to construct 400 running feet, more or less, of pier extension, to consist of eight cribs, each 50 feet in length, and 26 feet in width. The price of materials and labor under this contract is so favorable for the Government that, if it is found to be practicable, the contractors will build and place in extension of the piers ten cribs of the dimensions specified, five of which to be placed on the north, and five on the south side of the channel. I have been disappointed at the delay which has been occasioned to the work through a lack of suitable timber. The timber necessary for the construction of the work was cut during last winter and rafted. A heavy freshet which occurred in the spring broke everything loose in the Père Marquette River, from which point the timber is obtained, and jammed the logs so that it has been impossible to extricate the greater part of the long timbers. One of the cribs is, however, in readiness for sinking, and a large quantity of timber of short lengths is framed for use as soon as the complement of long timber arrives; this timber is expected daily. As soon as it arrives the work will be pushed vigorously. About four hundred cords of stone are on the ground in readiness for crib sinking.

On the 17th day of June, 1871, a contract was made with Mr. Henry Starke, of this city, to construct an additional extension of 150 running feet to each of the piers, to consist of two cribs, each 50 feet by 26 feet, and one crib of dimensions 50 feet in length by 30 feet in width on either side of the channel.

The whole of the work under these contracts, equal in length to 800 running feet of pier extension, is expected to be built to the water-surface by the 1st of December of the present year. On the 29th of August, 1870, the outer crib of the south pier was run into by some unknown vessel, which damaged it seriously, fairly splitting open the crib. The stone filling was saved and deposited in the pier; on the 17th day of last month the same crib was struck by the bark Lottie Wolf, inflicting more damage to the crib and sinking the vessel. Repairs will be made to this crib at an early date.

There is a beacon-light on the north pier at a distance of 280 feet, from its present easterly or outward extremity, the height of which is 48 feet above the water-surface, visible about eight and one half miles.

The completion of the work now in progress at this harbor will, it is believed, render any future appropriations unnecessary, at least for some years. It is to be remarked, however, that these works are of a temporary character, especially above water, and periodical expenditures will be necessary to maintain them in good condition. These periodical expenditures are a much less tax upon the Treasury than permanent structures, which would involve an enormous cost and require a long time for completion, while the interests of commerce would suffer.

A 14.

IMPROVEMENT OF RACINE HARBOR, WISCONSIN.

During the working season of 1870 the outer portion of the north pier was planked over, and the compartments on the south side of the end crib of the north pier were raised 2 feet and filled with stone, the crib having seriously settled, and the crib was decked with plank. Sixty feet of the south pier was repaired near its intersection with the shore, and the pier extension of 1867 and 1868 was ballasted with stone.

On the 30th of September, 1870, a contract was made by the Government with Mr. F. M. Knapp, under which he will construct 256 running feet of crib pier-work to the water-surface, 20 feet in width in extension of the south pier; of this he has built, and placed in accordance with specifications, 256 running feet.

On the 17th day of June, 1871, a further contract was made with Mr. Knapp for building superstructure over the four cribs, or 256 feet of pier, above specified, including also repairs to be made to a portion of the old work on the north pier.

The depth of water in this harbor channel is sufficient for the requirements of the commerce of the place.

A 15.

IMPROVEMENT OF KENOSHA HARBOR, WISCONSIN.

The work at this harbor in 1870 was the taking off the old superstructure for a length of 552 running feet of the south pier, and rebuilding it 12 feet in width; also closing apertures between cribs with plank and filling intervals or boxes with stone. During the month of March, 1871, the outer crib of the north pier, sunk in 1867, was removed to a distance of 9 feet east, and the same distance northward of the pier alignment at its southeast corner, and seven courses of the upper timbers were also torn off of the crib.

A contract was made with Mr. R. A. Conolly, of Chicago, on the 15th day of June, 1870, for extending the north pier, which will consist of close-piling around the displaced crib, and constructing and placing one crib 50 feet in length, by 30 feet in width, in extension of and upon alignment with the south face of the north pier. This contract also covers repairs to be made to the south pier. The work required at this harbor in addition to that now in progress, is the repair of the old superstructure of the north pier. Some dredging is also necessary between the piers. It is estimated that the sum of $10,000 will put this harbor in condition to meet all the requirements of commerce for some years to come.

A 16.

IMPROVEMENT OF CHICAGO HARBOR, ILLINOIS.

An appropriation of $100,000 having been made for the enlargement of harbor facilities at Chicago, Illinois, by the act of Congress approved July 11, 1870, a contract was made, after due advertising, for the construction of a breakwater, or so much of it as the funds available would admit, with Fox & Howard, of Chicago. The location of the breakwater is in accordance with the plans of Major J. B. Wheeler, Corps of Engineers, which were duly approved by the Department.

Work was commenced at the north end of the breakwater. During the year, twenty-nine cribs 50 by 30 feet have been sunk, making 1,450 feet of breakwater. Three hundred feet of this is a return of the north end of the breakwater running west. At the writing of this report the superstructure, 6 feet high, has been completed over 1,000 feet of the work done last fall. On the 30th of May, 1871, a contract was made with the Illinois Central Railroad Company for continuing the work, Congress having appropriated an additional $100,000, March 3, 1871. The work is now progressing rapidly, and it is estimated that the breakwater will be extended 900 feet up to water-surface the present season, and the superstructure be put on all by June 30, 1872. This will make about 2,000 feet of breakwater complete. The first crib was placed in 24 feet of water; no cribs have been placed in less than 18 feet, and, when necessary to obtain that depth, dredging has been resorted to. The cribs have stood remarkably well, though in a very exposed condition.

The sum of $200,000 can be advantageously expended on this work during one season.

A 17.

IMPROVEMENT OF HARBOR OF REFUGE AT THE MOUTH OF THE CALUMET RIVER, ILLINOIS.

By the act of Congress dated July 11, 1870, an appropriation was made for "enlargement of harbor facilities at Chicago, Illinois, according to the plans of the Engineer Department, $100,000; and for a harbor of refuge, $50,000." By letter of the Chief of Engineers, dated July 18, 1870, I was informed that this $50,000 was intended for the improvement of the mouth of the Calumet, and in pursuance of instructions I proceeded to carry out the plan of improvement recommended by Major J. B. Wheeler, Corps of Engineers, and approved by the Chief of Engineers. The improvement consists in cutting a channel from the Calumet River to Lake Michigan, and protecting the cut by piers and revetment.

The improvement had already been commenced by the Calumet and Chicago Canal and Dock Company. The old mouth of the Calumet River had been closed by a dam, in the expectation that the river would raise and the channel could be made at the desired point by the aid of the current. In this expectation they were disappointed, as the dam was put in too late in the season, and the surplus water of the river was drained by a feeder to the Illinois and Michigan Canal.

At the time I commenced work a dredge had commenced the work of cutting a channel from the lake to the river. A contract had been made by the company with Mr. Charles Mears, of Chicago, to cut a channel

200 feet wide and 8 feet deep, from the river to the lake, and to build a close dock or revetment on each side of the cut. Mr. Mears seemed confident of doing this by the time agreed upon, the 1st day of December, 1870. The first work I proposed to do was the construction of the north pier. This was necessary in order to stop the drift of sand along the shore, caused by northeasterly gales, which would otherwise fill up the channel faster than it could be excavated. Owing to the absence of any secure place at Calumet for constructing cribs, and the want of accommodation for workmen, I commenced the construction of cribs at Chicago, Illinois. Five cribs, each 64 feet long and 20 feet wide, were built in Chicago and towed to Calumet, a distance of about thirteen miles, and placed in the line of the north pier, the inner crib being 300 feet from the shore-line. I intended to close up this gap with a pile-pier, consisting of two rows of piles driven close and placed 14 feet apart, to be filled with slabs and capped by a superstructure of timber. Owing to the lateness of the season, and the constant interruptions from the weather, only the outer row of piles were driven, and an opening was left next to the cribs of 69 feet. In the mean time Mr. Means had completed a cut through the sand-bar, between the lake and the river, of about 50 feet in width and 7 feet deep. The dredge was constantly employed in maintaining this channel, which was necessary to secure a place of refuge for the pile-driver during storms. Had it not been that Mr. Mears had agreed to open this channel not at the expense of the Government, I should not have used a dredge until the gap in the north pier had been closed up, temporarily at least. As it was, I found it necessary to construct a temporary slab-pier to stop the sand from interrupting the work. The accretion of sand above the slab-pier was very rapid. The condition of the work at the close of operations last season was as described above. In the spring of 1871, about the 1st of March, there occurred a heavy freshet, which caused a rapid current in the river, cutting a channel 150 feet wide in the narrowest part, and from 8 to 10 feet deep.

At my first visit to the harbor last spring I directed the gap in the pier to be temporarily closed up to prevent any sand from getting into the channel; this done, operations were commenced looking to the extensions of the piers and improvement of the channel. The accretion of sand in the north side of the north pier now extends out to the cribs 300 feet from the original shore-line. This renders a less expensive revetment necessary than was designed. It is expected to extend the north pier 672 feet the present season, which will bring it to 12 feet of water in the lake. Four cribs, each 64 by 20 feet, have been placed in the south pier, and these connected with the shore by a pile-pier 184 feet in length. One dredge is employed in dredging for sinking cribs, and in good weather in widening and deepening the channel between the piers. When the dredge cannot work outside, it is employed by the canal company, at their expense, in the river. The work is now in fair progress. Vessels drawing 9 feet can make the harbor, and if wanted any required depth can soon be obtained. All the timber used for the work this spring has been brought by vessels across the lake and delivered on the river-bank. The work up to this time has been done by hired labor. The materials are furnished by contract. Owing to the risks and drawbacks attending the preliminary operations at this harbor, it would have been impracticable to have accomplished so much at the same cost by contract, and the work would have been greatly delayed. Hereafter I propose to do the work at this harbor entirely by contract, as all the facilities for doing the work are now to be had. Extensive improvements have been made by the company on the river and site of the city of South Chicago. Several hundred feet of docks have been put in, and a considerable amount of dredging in the river. The sand is being removed from the cut and used in making streets. A number of buildings and a hotel have been erected, and a railroad track laid to the mouth of the river connecting with the Michigan Southern Railroad. A large amount of timber has been shipped to this point for building purposes, and for shipment to the interior.

The original estimate for improving this harbor is, in round numbers, $300,000. One hundred thousand has been appropriated which will be expended during the fiscal year ending June 30, 1872.

The sum of $75,000 can be profitably expended in the extension of piers and dredging during the next fiscal year.

A 18.

IMPROVEMENT OF MICHIGAN CITY HARBOR, INDIANA.

The operations during the year at this harbor have consisted principally in dredging between the piers, and in widening and deepening Trail Creek nearly up to the railroad bridge, for the purpose of affording the additional harbor-room required. It seems impossible to maintain the required depth of water at this harbor, except by constant dredging. The mouth of the harbor is directly exposed to the action of storms which have the effect of forming bars. At the commencement of operations this spring there was ample depth of water at the mouth of the harbor in the ordinary stage. At the end of the piers there was 20 feet, and at the mouth, immediately between the piers, 12 feet. It seems, however, to continually shoal up, and the only remedy seems to be the construction of an outer harbor, which is much needed as a harbor of refuge.

The estimated cost of the outer harbor recommended by the board of engineers is $324,000. One difficulty about this harbor is the funnel-shape at the entrance. The piers originally having been but 100 feet apart, the western pier was made to flare out so as to make the entrance 230 feet wide. This causes a heavy sea at the entrance to the harbor.

The funds now available are sufficient for the necessary repairs of inside work and dredging. Future appropriations should be devoted to the construction of an outer harbor, which would protect the work already done, and enable the owners of property to construct wharves as the commerce of the place demands.

I think that a modification of the plan of outer harbor proposed by the board of engineers can be modified with advantage without additional cost.

The importance of a good harbor at Michigan City has been fully and favorably discussed in previous reports of officers of the corps and board of engineers.

A 19.

IMPROVEMENT OF NEW BUFFALO HARBOR, MICHIGAN.

The appropriation of $5,000 having been made by the act of July 11, 1870, for the improvement of this harbor, making with the amount available from former appropriations $11,050, a contract was made on the 10th of January, 1871, with R. A. Conolly for constructing a pile-pier from the shore outward in Lake Michigan for the purpose of protecting the channel to be excavated from Lake Pottawatomie to the lake. The materials for the work have been delivered, and the work is now in progress. . It is expected that about 300 feet of pier will be completed this season. This work is preparatory to future operations in case appropriations are made for this harbor. The amount appropriated is insufficient to produce any results. In my last annual report I submitted an estimate for the improvement of this harbor, amounting to $125,000. With that sum a good harbor might be made at this point. There does not seem to me to be any necessity for an artificial harbor at New Buffalo. The local requirements are insignificant. A harbor of refuge in that portion of Lake Michigan is very much needed, but that result can be obtained at Michigan City, ten miles west, where the Government has already expended large sums.

For these reasons no appropriation is recommended for this harbor.

A 20.

IMPROVEMENT OF THE FOX AND WISCONSIN RIVERS.

No active operations were carried on on this work during the year. On the 5th day of May, 1871, I relieved Colonel J. N. Macomb, in charge of the work, in compliance with Paragraph 7, Special Orders No. 124, dated War Department, Adjutant General's Office, Washington, March 28, 1871. The maps, &c., of the survey made in 1867 were in possession of Major G. K. Warren at Newport, Rhode Island, and it was not until the 8th of June, 1871, that I received from Major Warren at Newport such maps as were necessary for commencing operations.

Work was not commenced until the 1st of July, 1871. The works in progress this season have for their object to determine the practicability of improving the navigation of the Wisconsin River itself, by means of dikes and dams, and also whether the canal project recommended by Major Warren is feasible so far as relates to using the river in crossing from one side to the other. Hence the work at present is limited to the locations where the proposed canal crosses the river, and the work done will be available whatever plan is ultimately adopted.

The dikes and dams are built of brush and stone, which experience has shown to be best adapted for the purpose on this river. A special report will be submitted of the operations on this river at the close of the season, which it is thought will enable the Department to decide upon the ultimate plan of improvement. At that time estimates will also be forwarded.

A 21.

OFFICE OF UNITED STATES ENGINEERS,
Milwaukee, Wisconsin, December 17, 1870.

GENERAL: I have the honor to forward the accompanying map and report of a survey of the mouth of Oconto River, Wisconsin, made in pursuance of your instructions dated July 23, 1870.

I have indicated on the map two locations for the piers necessary for the improvement of the mouth of this river. A large amount of dredging will be required in either case.

The business at Oconto is principally lumbering. Large amounts of lumber are shipped from the mouth of the river. At present vessels are loaded from rafts or scows, which are towed out into the bay where the vessels are anchored. What is desired is a harbor where vessels can lie in safety at all times and receive their cargoes.

The general commerce and navigation will not be benefited by a harbor at this point. The improvement of the mouth of the river would increase the facilities for exporting lumber, and be a great *local* benefit. Oconto is but thirty miles from Green Bay, and but eight miles from the Peshtigo River, where there are good harbors. The bay at Oconto is but ten miles in width.

The amount required for the entire and permanent completion of the work is $500,000.

Oconto is in the collection district of Milwaukee, which is the nearest port of entry.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief Engineer of United States Army, Washington, D. C.

Report on the survey of the mouth of Oconto River, and estimates for its improvement submitted.

OFFICE OF UNITED STATES ENGINEERS,
Milwaukee, Wisconsin, December 17, 1870.

MAJOR: I have the honor to present you herewith a report on the survey of Oconto River, which was made last September, and to submit estimates for the improvement of the mouth of the river, based on the results of said survey.

The Oconto River has its mouth on the west coast of Green Bay, at a point thirty miles north of Green Bay City. The river is small, varying in size, and navigable only for small craft drawing four feet of water, as far as the town of Oconto, situated some three miles from its mouth. Its length is about seventy-five miles. From the entrance of the river, as far as to the town, the ground is low and marshy, and at high water is inundated. West of the town the ground is much higher, and about three miles up the river a dam, some ten feet high, has been erected, which affords a good water-power and runs one saw-mill. Above this the river is used mostly for logging purposes.

The town of Oconto has a population of 3,500. It contains several saw-mills, stores, hotels, churches, a town hall, and printing office. The steamer North West makes a daily trip from Green Bay City to this point. The business is mostly lumber, which is shipped in large quantities to Chicago and Milwaukee. On account of the shallow water in the river, vessels come to anchor in Green Bay, abreast of the river, and lumber rafts are towed to them. Three tugs are thus engaged on the river in towing rafts and scows from the mills to the vessels.

The following table shows the amount of business done during the past year:

Statement of lumber, &c., shipped from Oconto, Wisconsin, for the year 1870.

Lumber, 80,000,000 feet	$1,040,000 00
Laths, 10,000,000	20,000 00
Shingles, 20,000,000	70,000 00
Pickets, 2,000,000	12,000 00
Square timber, 1,500,000 feet	300,000 00
Cedar posts, 25,000	2,500 00
Fish, 3,000 barrels	45,000 00
	1,489,500 00

About 200 tons mixed merchandise, value	$400,000 00
The number of arrivals and departures of vessels was	1,456
The number of arrivals and departures of steamers was	306

During the past year the town has built a pile-pier extending some 1,800 feet into Green Bay, to 15 feet depth of water, the cost of which amounts to nearly $30,000. This money was raised by special tax on the town property, authorized by an act of the legislature. It is proposed to construct a wagon road, 50 feet wide, from this pier to the town, a distance of 6,920 feet, or a little over one and one-third miles, and to transport the lumber by rail to the pier, from whence it will be shipped by vessels.

To improve the river, and make it navigable for heavy draught vessels, will require an expenditure of half a million dollars, as will be seen by the estimates given herewith; and the benefits to be derived will be entirely local. No harbor of refuge is needed in that locality, as vessels can ride at anchor during the heaviest storms, besides which Peshtigo River, eight miles north, affords a good harbor with 13 feet depth of water; and on the east shore of Green Bay, twelve to eighteen miles from Oconto, are situated the natural harbors of Big and Little Sturgeon, which are always accessible.

PROPOSED IMPROVEMENTS.

Two plans are submitted for the improvement of the river:

The first plan consists in making a new channel from the lower steam saw-mill, in a direction nearly east, to the first bend in the river, taking advantage of the deep water inside the river at that point and the slab-piers already constructed, then extend the piers in the bay to the depth of 12 feet.

The second plan consists in dredging a new channel, from the same mill, in a northeasterly direction, cutting across the point to the river, and from thence across the marsh to the water of Green Bay, whence the crib-work will commence. The revetment of the cuts in both these plans to be made with slabs.

Estimates for these improvements are herewith respectfully submitted.

Cost of constructing one crib 32 feet by 20 feet by 17 feet.

2,508 lineal feet square timber, at 15 cents per lineal foot	$376 20
288 feet (board measure) 3-inch plank, at $15 per 1,000	4 32
3,146 pounds iron bolts, at 4 cents per pound	125 84
9 pounds spikes, at 6 cents per pound	54
62 cords stone, at $10 per cord	620 00
10 cords brush, at $3 per cord	30 00
Labor of framing and placing 2,508 feet timber, at 15 cents per lineal foot	376 20
	1,533 10

Cost of improving the present river entrance.

180 cribs 32 feet by 20 feet by 17 feet, at $1,533 10 each	$275,958 00
21,060 cords slabs, at $2 per cord	42,120 00
690,491 cubic yards dredging, at 30 cents per cubic yard	207,147 30
	525,225 30
Add 10 per cent. for contingencies	52,522 53
Total	577,747 83

Cost of making a new channel in a northeasterly direction.

150 cribs 32 feet by 20 feet by 17 feet, at $1,533 10 each	$229,965 00
22,440 cords slabs for revetment, at $2 per cord	44,880 00
592,600 cubic yards of dredging, at 30 cents per cubic yard	177,780 00
	452,625 00
Add 10 per cent. for contingencies	45,262 50
	497,887 50

I am, major, very respectfully, your obedient servant,

WILLIAM T. CASGRAIN, *Assistant.*

Major D. C. HOUSTON,
Corps of Engineers, U. S. Army, Milwaukee.

A 22.

OFFICE OF UNITED STATES ENGINEERS,
Milwaukee, Wisconsin, December 12, 1871.

GENERAL: I have the honor to forward the accompanying map and report of a survey of Two Rivers, Wisconsin, made in compliance with your instructions dated July 23, 1870.

In order to make use of these rivers, which are fully described in the accompanying report, as a harbor, it is necessary to widen and deepen the mouth, to revet the sides of the excavation and extend piers from the shore-line into the lake, according to the plan adopted at other harbors on Lake Michigan and elsewhere. I have indicated in the map the approximate position of the piers and revetment. The piers are placed 200 feet apart, and extend out to a depth of 18 feet of water. From the points marked "A" and "B," outward, it is proposed to construct the piers of crib-work; inside of these points a revetment of sheet-piling.

The accompanying papers furnish all obtainable facts bearing on the trade of this locality. As to the benefit to general commerce and navigation by a harbor at this locality, concerning which I am called upon to report, it is at present very slight. It is not probable that vessels engaged in the general commerce of Lake Michigan, *i. e.*, those bound to other points, would, except at rare intervals, seek a harbor at Two Rivers. The proximity of the harbor at Manitowoc, which is but six miles from the mouth of Two Rivers, and at present accessible to the great majority of vessels navigating the lake, is an argument against constructing a harbor at Two Rivers for general purposes. The location, however, is favorable to the construction of a harbor for local development, except that the length of pier required to reach deep water involves a heavy expenditure.

The amount required for the entire and permanent completion of the work is $265,588 80. There can be profitably expended during the next fiscal year, $75,000.

Two Rivers is in the collection district of Milwaukee, which is the nearest port of entry. There is no light-house at present at this point.

I am, general, very respectfully, your obedient servant,
D. C. HOUSTON,
Major of Engineers, U. S. Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, December, 1870.

MAJOR: I have the honor to submit, herewith, my report on the survey of the mouth of Two Rivers, Wisconsin, together with estimates, based on the result of said survey, for improving the mouth of the river.

The village of Two Rivers is situated at the mouth of the east and west branches of Two Rivers, from which it takes its name; is built mostly on land having an elevation of from 10 to 20 feet above Lake Michigan, and contains a population of about two thousand inhabitants, two-thirds of whom are of German origin. It has 1 pail and tub factory, 1 chair factory, 2 saw-mills, 3 churches, 1 school-house, 3 stores, 2 tanneries, 1 post-office, 3 hotels, and 1 town hall.

The east branch takes its rise in the county of Kewaunee, running thence in a southwesterly direction to the village of Mishicott, situated some eight miles from the village of Two Rivers, and from thence southerly to Lake Michigan.

The west branch takes its rise in Brown County, runs in a southeasterly direction to Neshoto, a small village situated some seven miles from Two Rivers, and from thence south to the village, where it forms a junction with the east branch, and together they empty into Lake Michigan. Both of these rivers are about eighty miles long, and of considerable size at their head-waters, and much increased in size and volume by numerous tributaries. The west branch is navigable for vessels drawing 7 feet of water, as far as Neshoto, and the east branch a distance of about four miles, with 10 feet depth of water. These rivers, from their sources to within eight miles of their mouth, afford a number of excellent water-powers, some of which are already being used for milling and log-driving purposes. On the east branch there have been erected four mill-dams for grist and saw mills; on the west branch are nine dams, five for milling purposes and the others used to facilitate the running of logs.

No better farming land can be found anywhere in the State than in the portion of country traversed by these rivers. Very little waste-land, or land unadapted to profitable cultivation, is to be found; and what there is, is mostly confined to the immediate vicinity of the lake-shore. The town of Two Rivers contains about 24,000 acres of land which was formerly covered with a dense growth of timber; about one-twentieth of this land is now under cultivation, producing wheat and other cereals unsurpassed in any other section of the country.

Two Rivers is included in the collection district of Milwaukee, which is the nearest port of entry. The nearest light-house north is Cana Island, coast-light of third order, eighty-eight miles distant; and south seven miles is Manitowoc light.

The benefits to be derived from making a harbor at this place would be, to add materially to the manufacturing and agricultural interests already developed in that section of the country, besides affording a shelter to a large number of vessels which frequent that locality, which is one of the most exposed points along the coast. All the shipping at this point is done over two piers built in the lake to depth of 15 feet of water, maintained by private enterprise, and exposed to the inconvenience of wind and sea from the lake side. At some seasons of the year no landings can be made.

Appended to this report is a statement of the shipments and receipts for the year 1869.

Receipts at port of Two Rivers, Wisconsin, during the year 1869.

30,350 green hides in bundles; 10,748 dry hides, loose; 135,990 pounds dry hides	$300,000 00
4,200 bundles general merchandise; 1,471,458 pounds merchandise	500,000 00
513 barrels salt	1,300 00
1,443 empty one-half barrels	1,100 00
	802,400 00

Shipments from port of Two Rivers, Wisconsin, for the year 1869.

1,158,381 pounds leather; 7,474 pounds glue-stock; 177,960 pounds hair	$975,600 00
35,424 tubs; 138,288 pails; 1,512 barrel-covers; 7,260 churns; 2,220 half-bushels; 840 pecks; 852 keelers in racks; 3,660 keelers in nests; 18,336 kannikins; 335,550 broom-handles; 37,060 gross clothes-pins; 279 butter-tubs; 6,818 fish-kits; 480 sleds	81,400 00
38,580 chairs; 1,544 bedsteads; 375 cribs	50,000 00
3,661 half-barrels fish; 174,250 pounds fish, fresh, in boxes; 11,100 pounds fish, fresh, in barrels	32,200 00
2,446 cords wood; 1,148 cords slabs	8,600 00
10,945,746 feet lumber; 2,770,550 laths; 131,782 pickets; 21,096 posts; 2,000 telegraph-poles; 2,444 ties	220,000 00
	1,367,800 00

Arrivals and departures of steamers and propellers at south pier, 1869	248
Arrivals and departures of steamers and propellers at north pier, 1869	100
Arrivals and departures of sailing-vessels at south pier, 1869	38
Arrivals and departures of sailing-vessels at north pier, 1869	108
Total	494

PROPOSED IMPROVEMENT.

This consists in building two parallel piers, 200 feet apart, into Lake Michigan, to 18 feet depth of water, and at the north extremity of the west pier to build a close-piling wing 280 feet in length, as shown in the accompanying tracing; and in dredging a channel between the piers and at the river entrance to a depth of 12 feet at lowest stage of water.

Detailed estimates for the construction of such work are herewith respectfully submitted.

A.—*Cost of constructing one crib* 32 *feet by* 20 *feet by* 17 *feet.*

2,508 linear feet of square timber, at 15 cents	$376 20
288 feet, board measure, 3-inch plank, at $15 per M	4 32
3,146 pounds iron bolts, at 4 cents per pound	125 84
9 pounds spikes, at 6 cents per pound	54
62 cords stone, at $8 per cord	496 00
10 cords brush, at $3 per cord	30 00
Labor of framing and placing 2,508 feet timber, at 15 cents per foot	376 00
	1,409 10
Add ten per cent. for contingencies	140 91
	1,550 01

B.—*Cost of constructing one crib* 50 *feet by* 25 *feet by* 21 *feet.*

6,140 linear feet timber, at 15 cents per foot	$921 00
450 feet, board measure, 3-inch plank, at $15 per M	6 75
8,902 pounds iron bolts, at 4 cents per pound	356 08
15 pounds spikes, at 6 cents per pound	90
143 cords stone, at $8 per cord	1,144 00
10 cords brush, at $3 per cord	30 00
Labor of framing and placing 6,140 lineal feet timber, at 15 cents per foot	921 00
	3,379 73
Add 10 per cent. for contingencies	337 97
	3,717 70

C.—*Total cost of improving the mouth of Two Rivers, Wisconsin.*

91 cribs 32 feet by 20 feet by 17 feet, at $1,550 each	$141,050 00
22 cribs 50 feet by 25 feet by 21 feet, at $3,717 70 each	81,789 40
280 feet close piling, at $12 per lineal foot	3,360 00
131,298 cubic yards dredging, at 30 cents per yard	39,389 40
Total	265,588 80

I am, major, very respectfully, your obedient servant,

WM. T. CASGRAIN, *Assistant.*

Major D. C. HOUSTON,
Corps of Engineers, U. S. Army, Milwaukee, Wis.

A 23.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, December 9, 1870.

GENERAL: I have the honor to submit the accompanying map and report of a survey of the mouth of Ahnepee River, Wisconsin, made in compliance with your instructions dated July 23, 1870.

It is found that just inside the mouth of the river there is a ledge of rock, and that, in order to obtain a basin of sufficient depth and capacity for vessels navigating the lake, it will be necessary to remove at least 30,000 cubic yards of rock, involving a heavy expenditure not called for by the local necessities or by general commerce and navigation. The locality, however, is very favorable for the construction of an outer harbor, as indicated in the map by blue lines. The bottom is generally clay, and the shore gravelly, and there is very little drift on the lake shore. The conditions are favorable both for the construction and permanence of the basin.

The accompanying report furnishes all the obtainable facts bearing on the trade of this locality.

As to the benefit to general commerce and navigation by a harbor at this point, an inspection of the chart of Lake Michigan shows the nearest harbors to be Bailey's Harbor on the north, a distance of forty miles, and Manitowoc on the south, a distance of forty-three miles. The security of navigation on this lake requires frequent harbors. By multiplying harbors, lake navigation may be made as safe as that of a river, and for a similar class of vessels. On the west side of Lake Michigan there are eight artificial harbors nearly finished and in process of construction, from Calumet River to Manitowoc, a distance of one hundred and seventy-seven miles, making the average interval about twenty-five miles. From Manitowoc to Bailey's Harbor the distance is about eighty-three miles, so that it is evident that a harbor at Ahnepee would be a great benefit to the general navigation of the lake as a harbor of refuge.

The amount required for the entire and permanent completion of the work is $370,000. There can be profitably expended during the next fiscal year $100,000.

Ahnepee is in the collection district of Milwaukee, which is the nearest port of entry.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers, U. S. Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

Report and estimates for improving the mouth of Ahnepee River and constructing an outer harbor.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, December 9, 1870.

Major: I have the honor to submit herewith my report on the survey of the mouth of Ahnepee River, Wisconsin, together with estimates, based on the result of said survey, for improving the mouth of the river, and constructing an outer harbor.

AHNEPEE OR WOLF RIVER

Empties itself into Lake Michigan at a point about one hundred and twenty-two miles north of Milwaukee. The town of Ahnepee is located near the mouth of the river in Kewaunee County, and is thirty-five miles east of Green Bay City. Its population is estimated at nearly one thousand inhabitants, while that of the county is some twelve thousand. The river runs in a northwesterly course, and is navigable as far as the first rapids, which is some seven miles distant from the mouth, with a depth of water not less than 6 feet.

The country bordering on the river is undulating, and has a fertile soil. Along its banks we find heavy timber land of maple, beech, and oak, and at intervals some clearings and good farms. The amount of agricultural district centering at this point, and which has no other outlet, comprises the towns of Pierce, Casco, Lincoln, Brussels, Forestville, and Ahnepee. The products are chiefly corn, wheat, rye, oats, barley, peas, beans, and potatoes. The manufactories consist of 2 flouring-mills, 4 saw-mills, 1 chair-factory, 1 brick-yard, 3 tanneries, 1 brewery, 1 ship-yard, and 1 shingle-mill. Nearly every branch of industry, but principally the manufacturing interests, has been held in check by the monopoly of the Bridge-pier Company, exorbitant charges being made for dockage and shipments over the pier.

PRESENT IMPROVEMENT.

This consists of a pile pier which was built some eight years ago. It extends into Lake Michigan to a depth of 18 feet, and is 860 feet in length. This pier is all the facility afforded for the shipping interest. About six years ago an attempt was made by the citizens of the town to open a straight cut across the narrow sand and gravel beach abreast of the mouth of the river. They first drove two rows of close piles across the point from the river to the lake, a distance of 90 feet, and dug out a channel across to a depth of 5 or 6 feet. For want of funds this enterprise was afterwards given up, and nothing further has been done.

By an act of the legislature, which was passed last winter, the town was authorized to raise, in three years, $20,000 by taxation, for the purpose of improving the mouth of the river, and making it accessible for vessels of small draught. The amount raised this year is $6,000. It was at first contemplated to open a channel at the mouth of the river, and protect the sides of the cut with close piling, but since the survey has been made the commissioners have decided to wait and see what action Congress would take in the matter. They have, however, stated in writing that "should the Government build a harbor at that point they will give sufficient guarantee to make a channel through the bed of limestone, near the mouth of the river, that will pass the largest class of lake vessels."

Ahnepee is situated at a point nearly equally distant between Bailey's Harbor and Manitowoc, the former being forty miles north and the latter forty-three miles south. Its nearest light-house is on Cana Island, situated about five miles north of Bailey's Harbor, or forty-five miles north of Ahnepee. The illuminating apparatus is of the third order; the tower is 88 feet high.

There is, then, eighty-two miles of coast which affords no shelter during heavy storms to the large fleet which frequents that locality. A large number of vessels are regularly engaged in the lumber trade to ports in Green Bay and Big and Little Bay de Noquette; also, transporting copper and iron ore from Escanaba to Milwaukee and Chicago, and their course is within twelve miles of Ahnepee. It would seem from the location that this point would be the best for making a harbor of refuge. There is, however, one drawback to it, on account of the limestone which lies under the bed of the river near the entrance.

It was found impracticable, while making the survey, to take cross-section borings throughout to the rock for want of proper tools. However, a sufficient number of borings were made, at different intervals, to give a general idea of the quantity of rock to be excavated upon which to base an estimate. To remove the rock in the river as far as the bridge, a length of 700 feet by 150 feet wide, and an average depth of 8 feet, so as to insure 12 feet at the lowest stage of water, and make a sufficient basin inside to accommodate the wants of the locality, would require the removal of—

31,111 cubic yards of rock, at $30 per cubic yard, (a fair estimate)	$933,330
70,000 cubic yards of dredging, at 30 cents per cubic yard	21,000
650 feet close-piling, at $10 per lineal foot	6,500
1,200 feet of crib-pier, at $50 per lineal foot	60,000
700 feet of crib-pier, at $75 per lineal foot	52,500
	1,073,330

It will be seen at once that this plan of improving the river is impracticable on account of the large expenditure required. The question then arises: What is to be done? As before mentioned, Ahnepee is the most central point along the coast for a harbor of refuge, and some means must be devised to secure a shelter there if possible. We are, then, obliged to adopt some plan for an outer harbor similar to Chicago, only much smaller and less expensive. Such a plan is therefore submitted, and is shown on the accompanying tracing, in blue lines, with estimates for the construction of the same.

The bottom of the lake being mostly clay, and affording good holding ground, I think there will be no necessity of dredging before placing the cribs in position. From the shore, to a depth of 10 feet, a close pile-pier at each end can be substituted for crib-work, which will answer the purpose and be perfectly secure. However, as this plan may be hereafter changed, I herewith submit estimates for piers built entirely of crib-work. The prices of materials mentioned in the estimates are the current prices paid in that locality:

A.—*Estimated cost of one crib, 32 feet by 20 feet by 17 feet.*

2,508 linear feet of square timber, at 15 cents per foot	$376 20
288 feet, board measure, 3-inch plank, at $15 per M	4 32
3,146 pounds iron bolts, at 4 cents per pound	125 84
9 pounds spikes, at 6 cents per pound	54
62 cords stone, at $6 per cord	372 00
10 cords brush, at $3 per cord	30 00
Labor of framing and placing 2,508 feet timber, at 15 cents per foot	376 20
	1,285 10
Add 10 per cent. for contingencies	128 51
	1,413 61

B.—*Estimated cost of one crib, 50 feet by 25 feet by 21 feet.*

6,140 linear feet of timber, at 15 cents per foot	$921 00
450 feet, board measure, 3-inch plank, at $15 per M	6 75
8,902 pounds iron bolts, at 4 cents per pound	356 08
15 pounds spikes, at 6 cents per pound	90
143 cords stone, at $6 per cord	858 00
10 cords brush, at $3 per cord	30 00
Labor of framing and placing 6,140 lineal feet timber, at 15 cents per foot	921 00
	3,093 73
Add 10 per cent. for contingencies	309 37
	3,403 10

C.—*Estimated cost of one crib 50 feet by 30 feet by 30 feet.*

9,403 linear feet of square timber, at 15 cents per lineal foot	$1,410 45
405 feet, board measure, 3-inch plank, at $15 per M	6 75
13,088 pounds of iron bolts, at 4 cents per pound	523 52
15 pounds spikes, at 6 cents per pound	90
284 cords stone, at $6 per cord	1,704 00
Labor of framing and placing 9,403 lineal feet timber, at 15 cents per foot	1,401 45
	5,056 07
Add 10 per cent. for contingencies	505 60
	5,561 67

D.—*Total cost of constructing an outer harbor at Ahnepee, Wisconsin.*

37 cribs, 32 feet by 20 feet by 17 feet, at $1,413 61 each	$52,303 57
24 cribs, 50 feet by 25 feet by 21 feet, at $3,403 10 each	81,674 40
42 cribs, 50 feet by 30 feet by 30 feet, at $5,561 67 each	233,590 14
Total	367,568 11

Appended to this is a statement of the amount of exports and imports at Ahnepee, Wisconsin, for the past year.

Amount of exports at Ahnepee for the year 1870.

Articles.		Quantity.	Value.
Flour	barrels.	20,000	$120,000
Fish	do..	15,000	90,000
Wheat	bushels.	200,000	200,000
Oats	do..	75,000	37,500
Barley	do..	50,000	75,000
Rye	do..	20,000	20,000
Peas	do..	5,000	10,000
Potatoes	do..	18,000	15,000
Wool	pounds.	50,000	20,000
Butter	do..	100,000	20,000
Hay	tons.	2,000	24,000
Cord-wood	cords.	6,500	20,000
Tan-bark	do..	4,000	20,000
Railroad ties	number.	100,000	10,000
Telegraph poles	do..	6,000	6,000
Cedar posts	do..	200,000	20,000
Bricks	do..	2,000,000	20,000
Staves	do..	200,000	50,000
Leather			50,000
Lumber, feet, board measure	number.	500,000	15,000
Shingles	do..	1,000,000	4,000
Chairs and bedsteads	do..	2,000	4,000
			850,500

Imports at Ahnepee, Wisconsin, for the year 1870.

General merchandise, $500,000.
Arrival of vessels, 200; steamers, 34, propellers, 192.
Departures of vessels, 200; steamers, 34, propellers, 192.
The nearest port of entry is Milwaukee, Wisconsin.

I am, major, very respectfully, your obedient servant,

WM. T. CASGRAIN, *Assistant.*

Major D. C. HOUSTON,
Corps of Engineers, U. S. Army, Milwaukee, Wisconsin.

A 24.

UNITED STATES ENGINEER OFFICE,
Chicago, September 1, 1871.

GENERAL: I have the honor to submit the following report of an examination of Grand Marais Harbor, Michigan, made in pursuance of the act of Congress approved March 3, 1871.

Grand Marais Harbor is situated on the south shore of Lake Superior, about forty-nine miles west of White Fish Point, and forty miles east of Grand Island Harbor. The only harbor affording a refuge for vessels navigating Lake Superior, between White Fish Point and Marquette, a distance of one hundred and twenty miles, is Grand Island.

Grand Marais Harbor seems to have been formerly a part of the Lake, and is now separated from the lake by two narrow tongues of land formed of the lake drift.

The western tongue is much larger than the eastern, and is composed of sand and small boulders. The whole length of the harbor is two miles, and the width at the widest part about 2,000 feet. The entrance is about 3,000 feet wide, and the deepest water on the bar 7 feet. The water in the harbor is from 30 to 50 feet deep very near the shore. No survey has been made of this harbor since the lake survey of 1867. I submit herewith an enlarged copy of this survey, giving proposed location of piers for improving the entrance. I made an examination of this harbor on July 22, 1871, and found that no essential changes had occurred since the survey. The position of the channel varies from time to time. When I was there the channel was much nearer the eastern point than is shown on the map. The piers are so located on the map as to give the minimum amount of pier-work, and it will not be necessary to dredge for placing the cribs. It also allows the sea to spread out immediately after passing the ends of the piers. The estimated cost of improving this harbor is as follows:

2,400 feet of pier-work, 20 feet wide, at $40	$96,000
1,500 feet of pier-work, 25 feet wide, at $75	112,500
1,400 feet of pier-work, 30 feet wide, at $120	168,000
Dredging 175,000 cubic yards at 35 cents	61,250
	437,750
Contingencies, 10 per cent	43,775
	481,525

It will be seen from this estimate that owing to the wide entrance of this harbor, and the long distance to which the piers must be extended in order to reach 18 feet of water, the improvement in the manner described, which seems to be the most economical that can be desired for a complete work, will cost more than a purely artificial harbor at a point on the coast where the water is bolder, and no dredging, and a less breadth of pier necessary. It is possible, though not certain, that a single pier in the position marked XY would have the effect to improve the entrance during northwesterly gales; which would drive the water into the harbor and scour out a channel along the pier. This, however, is uncertain and if the anticipated result did not occur, it would be necessary to build another pier, and to dredge out a channel, at a total cost not less than that of the project submitted. The only inhabitants at Grand Marais are a few fishermen, so that the only object of improving this harbor is to afford a harbor of refuge between two points on the shore eighty-nine miles apart. Vessels going east, or encountering northeasterly gales, can run to Grand Island Harbor; while those going west can in like manner take shelter under White Fish Point.

While a harbor at this point would doubtless be very convenient, it does not seem to be necessary to improve it at a great cost.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

UNITED STATES ENGINEER OFFICE.
Chicago, Illinois, September, 27, 1871.

GENERAL: I have the honor to acknowledge the receipt of your letter of the 16th instant, calling for additional information in regard to Grand Marais Harbor, Lake Superior.

In regard to the substitution of two parallel piers located on or about the line of those in my plan, for the plan I proposed, I think that there will be little, if any, saving of cost, for the reason that the beds for the cribs will require dredging, and the cribs will have to be much deeper than those composing the oblique piers which I propose. The saving in length of pier will be more than counter-balanced by increased cost of dredging and cribs. I submit the following estimate of cost of parallel piers in this locality from a depth of 15 feet inside to a corresponding depth outside.

Estimates for building two parallel piers 600 feet apart at the present entrance to Grand Marais.

Mean depth of dredging below water, 57 feet. Width of dredging, including space for sinking cribs, 660 feet. Length of dredging to 14 feet water, 1,500 feet.

East pier 1,300 feet, 20 feet base.
East pier 400 feet, 25 feet base.
West pier 900 feet, 20 feet base.
West pier 700 feet, 25 feet base.

2,200 feet of piers, 20 feet base, at $50	$110,000 00
1,100 feet of piers, 25 feet base, at $75	82,500 00
208,260 cubic yards dredging, at 35 cents	72,891 00
	265,391 00
Add 10 per cent. for contingences	26,539 10
	291,930 10

Moreover, I think it will be necessary to connect these piers with the shore in order to secure the proper protection, which will involve additional expense. My plan had for its object to make the entire harbor of Grand Marais available for anchorage. As, however, this harbor is much more spacious than is needed at present for a harbor of refuge, it will be possible to effect an improvement at much less cost than my estimate, by considering the western portion of the harbor only, and improving that.

I inclose a tracing showing the proposed location of two parallel piers, and a cut through the tongue of land which forms this part of the harbor.

It will be observed that the length of piers required is much less than at the present entrance, and a cut of 150 feet in length only is necessary to connect the waters of the harbor with the lake. I have made the distance between the piers but 300 feet, for economy of dredging.

The following estimate of cost is submitted for this improvement:

Estimated cost of building two parallel piers, 600 feet apart, and cutting a new channel across the point.

Average depth of dredging below water, 6.65 feet; width of dredging, including space for sinking cribs, 660 feet; length of dredging, to 14 feet water, 500 feet; length of dredging on point, 660 feet; width of point, 150 feet; mean height above lake surface, 5 feet + 14 feet = 19 feet.

East pier-cribs, 20 feet base = 700 feet.
East pier-cribs, 25 feet base = 200 feet.
West pier-cribs, 20 feet base = 700 feet.
West pier-cribs, 25 feet base = 200 feet.

1,400 feet of crib-work, 20 feet base, at $50	$70,000 00
400 feet of crib-work, 25 feet base, at $75	30,000 00
89,405 cubic yards dredging in Lake Superior, at 35 cents	31,291 75
70,564 cubic yards dredging on point, at 30 cents	21,169 20
	152,460 95
Add 10 per cent. for contingencies	15,246 09
	167,707 04

The width of channel may be lessened and the cost of dredging diminished. The two narrow tongues of land which form the protection to this harbor are evidently formed by the lake-drift, produced by northwesterly and northeasterly winds. The eastern tongue is fine sand above the water-level; but in the lake, below the water-surface, there is small gravel. This tongue or sand-spit has not changed materially since the survey of 1867, as shown by the position of the wreck noted in the survey, which is still visible. The western sand-spit is composed of sand, gravel, and cobble-stones, and the shore to the west of the harbor is composed of the same materials. The wind being quite strong from the northwest at the time I visited the harbor, I was enabled to observe the action of the waves, the effect of which is to stir up the sand and shingle, and, by striking the shore obliquely, to cause a strong littoral current, carrying the material stirred up by the waves, and held by them temporarily in suspension, to the eastward, and depositing it at the point, the coarser material being dropped first and the finer carried round until it also is deposited. Passing round the point of this tongue of land, the material becomes finer and finer until the smooth water is reached, where there is only sand. I have had occasion to observe this action closely in Lake Michigan, and have no doubt but here tongues of sand are formed by the drift of shingle during northeasterly and northwesterly storms, and that the action is still going on. The northwesterly winds being most prevalent, as shown by the inclination of trees near the shore, accounts for the greater extension on the western side of the harbor. I have no doubt that the extension is still going on, though I have no data for determining its rate, as no instrumental survey was deemed necessary for determining the question of improving this harbor. The only accurate information I have been able to obtain has been from the lake survey. The only inhabitants are fishermen, in the summer season, and very little could be elicited from them. I find the following note on a map of Lake Superior in my possession, which I think is taken from Bayfield's chart:

> Grand Marais, the channel is 15 fathoms wide, and 3 feet deep at the entrance, but the bar of the Grand Marais varies with every gale. It has seldom more than three feet of water.

Such is about the tenor of all the general information that I have been able to obtain on the subject, and it seems to me apparent that the changes which take place in the bottom of the entrance to this harbor must be irregular and subject to no law. The location of piers for the improvement of the harbor entrance is to be considered with reference to economy and convenience of access.

I am, general, very respectfully, your obedient servant,

D. C. HOUSTON,
Major of Engineers.

Brigadier General HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

APPENDIX B 1.

Annual report of Captain F. U. Farquhar, Corps of Engineers, for the fiscal year ending June 30, 1871.

1. REPORT OF OPERATIONS AT AUX BECS SCIES HARBOR.

The wings on east ends of north and south pile revetments were each extended 210 feet. After due advertising and opening of proposals a contract for furnishing timber and stone was, November 11, 1870, awarded to C. S. Stevens, and on April 17, 1871, to William Nicolls, for framing and sinking three cribs, 64 feet by 20 feet. Nicolls has already sunk one crib on the north pier extension, and would have sunk another had it not been for the non-fulfillment of Stevens's contract. Stevens's contract being annulled, I at once proceeded to buy timber and stone in open market, and purchased it at the same rates as contracted for by Stevens.

Under a contract made with T. Stewart White, dated May 5, 1871, the channel between the piers has been dredged to a depth of 12 feet below the surface of the water, which is not shown on the accompanying tracing, as the survey was made before the dredging had made any headway. The detailed cost of the work for the past fiscal year was as follows:

8,320 linear feet piles, at 7½ cents per foot..............	$624 00
2,233⅓ cubic feet pine timber, at 13½ cents per foot...	301 53

3,336$\frac{1}{3}$ cubic feet hemlock timber, at 11$\frac{78}{100}$ cents per foot...	$393 02
412 feet board measure plank, at 13$\frac{18}{100}$ per M...............	5 43
3,540 pounds drift-bolts, at 3$\frac{1}{4}$ cents per pound..............	115 05
3,305 pounds drift-bolts, at 3$\frac{5}{8}$ cents per pound..............	119 81
256$\frac{43}{100}$ cords stone, at $10 50 per cord	2,692 51
66 cords stone, at $9 87 per cord	651 42
108$\frac{38}{100}$ cords slabs, at 50 cents per cord	54 19
Tools...	64 28
Driving 351 piles, at $1 each	351 00
Framing 4,160 linear feet timber, at 12 cents per foot.......	499 20
Dredging sand 40.2 days, at $104 per day	4,180 80
Re-handling 100 cords stone, at $2 25 per cord..............	225 00
Filling 558.89 cords brush into pier, at 97 cents per cord....	542 12
Filling 87$\frac{2}{10}$ cords slabs into pier, at 80 cents per cord......	69 76
Labor...	681 72
Superintendence	991 86
Advertising	152 25
Total..	12,714 95

Amount on hand, July 1, 1870	$8,280 90
Appropriation approved July 11, 1870	10,000 00
Appropriation approved March 3, 1871....................	10,000 00
	28,280 90
Less amount covered in the Treasury of appropriation for repairs, &c., by act approved July 12, 1870...............	5,721 50
	22,559 40
Less amount expended during fiscal year.................	12,714 95
Amount on hand July 1, 1871	9,844 45

Which amount will be entirely exhausted during the present season.

During the present season two cribs 64 feet by 20 feet in plan will be placed, one on each pier. To make the improvement of this harbor complete, the piers should be further extended as recommended in my last report; the north pier 264 feet, and the south pier 328 feet, and the whole of this should be done in one season, so as to push beyond the bar. The channel should also be dredged to a depth of 14 feet. This work would cost $56,000, which can be profitably expended during the fiscal year ending June 30, 1873.

Aux Becs Scies, or Frankfort, is in the collection district of Michigan, and the nearest port of entry is Grand Haven. Its nearest light-house is on Point Aux Becs Scies, or Point Betzie, as it is generally known.

Abstract of proposals received and opened October 31, 1870, *for furnishing stone and timber at harbor of Aux Becs Scies, (Frankfort,) Michigan.*

Names of bidders.	Residence.	Timber per cubic foot.		Per cord.	Remarks.
		Hemlock.	Pine.	Stone.	
		Cents.	*Cents.*		
C. S. Stevens	Frankfort, Mich	11.78	13.00	$9 87	Contract awarded to C. S. Stevens.
L. W. Crane	do	13.50	14.50		
Wing & Buckley	Manistee, Mich			11 00	

Abstract of proposals received and opened April 7, 1871, *for framing, bolting, and sinking cribs, and moving stone from place of deposit and putting it in place in cribs at Aux Becs Scies Harbor, (Frankfort,) Michigan.*

Names of bidders.	Residence.	Framing per linear foot.	Moving stone per cord.	Remarks.
Wm. Nicolls	Detroit, Mich	$0 12	$2 25	Contract awarded to Wm. Nicolls.
Frederick L. Tebel	Milwaukee, Wis	22½	1 50	
Samuel G. Hart	Fulton, N. Y	16	3 00	

Abstract of bids received and opened May 4, 1871, *for dredging at the harbor of Aux Becs Scies, (Frankfort,) Michigan, to a depth of* 12 *feet of water.*

Names of bidders.	Residence.	No. cubic yards that dredge can remove per day.	Amount rent per day.
T. Stewart White*	Grand Huron, Mich	480	$104
N. J. Dodge & Co	Cleveland, Ohio	400	115
Hugh Maher	Chicago, Ill	250	150

* Contract awarded to T. Stewart White.

Abstract of contracts awarded for improving harbor of Aux Becs Scies, (Frankfort,) Michigan.

Contractors.	Nature of contract.	Price.
C. S. Stevens	Hemlock timber per cubic foot	$11 78.
Do	Pine timber per cubic foot	13.
Do	Stone delivered	9 87 per cord.
William Nicolls	Framing and moving stone	12 cents per lin'r foot. 2 25 per cord.
T. Stewart White	Dredging	104 00 per day.

Statement of imports at Aux Becs Scies Harbor, (Frankfort,) Michigan, showing articles and value for year ending June 30, 1871.

Articles.	Tons.	Barrels.	Bushels.	Value.
Butter and lard		60		$2,495
Beef				960
Boots, shoes, and leather				11,297
Crockery				1,500
Corn			1,900	1,285
Dry goods				20,250
Feed	105			1,028
Flour		1,945		11,798
Fish				268
Groceries				26,638
Hay	100			1,695
Hardware				10,885
Iron ore	6,884			41,068
Lime, stucco, plaster		190		230
Live stock				2,900
Oats			1,810	1,120
Pork		1,112		8,500
Salt and wood				3,995
Total				147,932

Statement of exports from Aux Becs Scies Harbor, (Frankfort,) Michigan, showing articles and value for year ending June 30, 1871.

Articles.	Feet.	Number.	Cords.	Tons.	Value.
Bark			484		$1,278
Iron, pig				3,400	119,000
Lumber	1,461,462				21,921
Lath	116,550				239
Timber	200,000				3,000
Ties, railroad		2,700			540
Posts, fence		1,100			500
Poles, telegraph		1,150			575
Wood			285		855
Merchandise					2,981
Total					150,889

B 2.

REPORT OF OPERATIONS AT THE HARBOR AT MANISTEE, MICHIGAN.

After due advertising and opening of proposals, contracts were, August 27, 1870, awarded to Peirce & Whaling, for furnishing iron, to C. Fitzsimmons, for furnishing stone, and to C. S. Stevens for furnishing timber.

Under these contracts, the iron, and so much of the stone as there was room to receive, were received. Stevens failing to fulfill his contract, it was annulled, and the required timber was purchased in open market at one cent less per thousand, board measure. There was great danger of a breach at the east end of the north pier, through the old slab revetment. This was averted by rebuilding the slab-work; the town authorities driving a few piles and furnishing the slabs, and the United States furnishing the labor. A crib, 64 feet by 20 feet, was commenced last season; but, owing to the inclement season, it was not sunk until this season.

After due advertising and opening of proposals, April 7, 1871, a contract for framing and sinking cribs was awarded to R. P. Thurber. Under this contract considerable framing has been done, but no cribs sunk.

The following is the cost of materials and labor during the past fiscal year:

113,276 feet (board measure) pine and hemlock timber, at $11 86 per thousand	$1,343 45
85,655 feet (board measure) oak and hemlock timber at $11 85 per thousand	1,015 01
$358\frac{77}{100}$ cords of stone, at $10 40 per cord	3,731 20
24,358 pounds of drift-bolts, at $3\frac{65}{100}$ cents per pound	889 06
2,626 pounds of screw-bolts at $4\frac{7}{10}$ cents per pound	123 42
Tools	133 77
Labor	2,097 95
Superintendence	919 40
Total	10,253 26

Amount on hand July 1, 1870	$1,255 54
Appropriation approved July 11, 1870	20,000 00
Appropriation approved March 3, 1871	9,000 00
	30,255 54
Less amount expended during fiscal year	10,253 26
Amount on hand July 1, 1871	20,002 28

During the present season two (64 feet by 20 feet) cribs and one pier-head crib (30 feet square) will be placed on the prolongation of each pier Here, as at several other harbors under my charge, the slab-piers built by citizens are commencing to give way, by reason of the decay of the slabs above water, and these being washed or blown away, those under soon are loosened and carried out into the channel.

I am of the opinion that the north side of the channel will have to be protected by a pile revetment from the east end of the north pier 850 feet inward. This work will cost, at $16 25 per foot, $13,812 50. As this work is imperative, it will be commenced with whatever funds that may be available after the extension of the piers is completed. There will be necessary, therefore, in order to complete this work, and to cut off the angle on south side of channel, a further appropriation of $13,812 50.

Manistee is in the collection district of Michigan. There is a light-house on the north side of the entrance.

Abstract of bids received and opened August 27, 1870, for improving harbor at Manistee, Michigan.

Names of bidders.	Residence.	Timber, per 1,000 board measure.	Stone, per cord.	Drift-bolts, per pound.	Screw-bolts, per pound.
C. S. Stevens	Frankfort, Michigan	$11 86	$10 43		
C. Fitzsimons	Chicago, Illinois		10 40		
Pierce & Whaling	Milwaukee, Wisconsin			3. 65 cts.	4. 07 cts.
Lewis, Oliver & Phillips	do			3. 85 cts.	5. 35 cts.
Wing & Buckley	Manistee, Michigan		11 97		

Abstract of proposals received and opened April 7, 1871, *for framing, bolting, and sinking cribs, and moving stone from place of deposit, and putting it in place, in cribs, at Manistee Harbor, Michigan.*

Names of bidders.	Residence.	Framing, per linear foot.	Moving stone, per cord.	Remarks.
R. P. Thurber	Manistee, Michigan	$0 10	$2 00	Contract awarded to R. P. Thurber.
Samuel G. Hart	Fulton, New York	14	2 00	
John A. Jamieson	Manistee, Michigan	13	1 45	
Fred. L. Tebel	Milwaukee, Wisconsin	22½	1 50	
Duncan Dewar	Ludington, Michigan	12	2 00	
Thomas N. Reynolds	Manistee, Michigan	16	1 75	
William Nicolls	Detroit, Michigan	10	2 25	

Abstract of contracts for material for improving harbor at Manistee, Michigan.

Contractors.	Nature of contracts.	Price.
C. S. Stevens	Timber	$11 86 per thousand, board measure.
C. Fitzsimons	Stone	$10 40 per cord.
Peirce & Whaling	Drift-bolts	3. 65 cents per pound.
Peirce & Whaling	Screw-bolts	4. 7 cents per pound.
R. P. Thurber	Framing timber and moving stone	10 cents per linear foot, $2 per cord.

Statement of vessels entered Manistee Harbor, showing the number, tonnage, crews, and cargoes, for the year 1870.

Vessels	number	1, 275	Corn	bushels	17, 550
Tonnage	tons	251, 327	Grain, (not specified)	do	750
Crews	number	10, 357	Potatoes	do	1, 020
Lumber	M feet	20, 579	Butter	pounds	56, 300
Pig-iron	tons	45	Flour	barrels	11, 111
Stone	cords	157	Feed	bags	10, 797
Coal	tons	74	Pork	barrels	2, 372
Lime	barrels	734	Beef	do	772
Brick	M	146	Hay	tons	1, 487
Salt	barrels	303	Live stock	head	1, 672
Wheat	bushels	396	Apples	bushels	1, 169
Oats	do	60, 717	Merchandise	packages	39, 323

Statement of vessels cleared Manistee Harbor, showing the number, tonnage, crews, and cargoes, for the year 1870.

Vessels	number	1, 275	Oats	bushels	2, 540
Tonnage	tons	248, 841	Grain, (not specified)	do	692
Crews	number	10, 355	Flour	barrels	930
Wood	cords	19, 630	Pork	do	122
Timber	M feet	458	Beef	do	583
Lamber	do	139, 808	Hay	tons	85
Lath	M	250	Hides	bundles	17
Shingles	do	764	Live stock	head	130
Pickets	do	8	Fish	barrels	88
Pig-iron	tons	48	Pigeons	dozen	90
Salt	barrels	67	Merchandise	packages	8, 165

B 3.

REPORT OF OPERATIONS AT THE HARBOR AT PÈRE MARQUETTE, MICHIGAN.

The superstructure on north pier was finished, and both piers were thoroughly reballasted.

After due advertising and opening of proposals, May 4, 1870, contracts were awarded to Peirce & Whaling for iron bolts, and to Duncan

Dewar for all the remaining materials, and all the work except pile-driving, required to build a pier-head to north pier, and 200 feet of pile-work. The only bid for pile-driving was excessive, and therefore rejected. A pile-driver was hired to drive piles at $1 70 per pile. As soon as the machinery could be gotten ready the dredging apparatus was sent from White River Harbor to this harbor, and there is now a channel 12 feet deep between piers.

Since dredging the channel the dredge has been at work removing slabs from old slab-pier and sand to give place for putting in the pile-pier connecting the east end of south pier and the shore.

The cost of the work was as follows:

12,126 linear feet timber, at 12 cents per foot	$1,515 75
97 cords of slabs, at $1 49 per cord	144 53
$350\frac{561}{1000}$ cords of stone, at $11 50 per cord	4,031 45
3,180 linear feet Norway pine piles, at 10 cents per foot	318 00
Dredging	5,107 59
Framing 12,126 linear feet timber, at 14 cents per foot	1,697 64
Labor, resetting, refilling, &c., three cribs	192 63
Superintendence	1,170 88
Advertising	30 00
Total	14,208 47

Amount on hand July 1, 1870		$5,831 30
Appropriation, approved July 11, 1870		10,000 00
Appropriation, approved March 3, 1871		10,000 00
		25,831 30
Less amount covered in Treasury, repairs, &c., by act approved July 12, 1870	$1,830 50	
Amount expended during fiscal year	14,208 47	
		16,038 97
Amount on hand July 1, 1871		9,792 33

During the present season the pier-head to the north pier will be placed, and the pile-pier connecting the east end of south pier and the shore will be built, which work will entirely exhaust the above balance.

The necessity for the removal of the old slab-pier on south side of channel has become almost imperative. The slabs above water are rotten, and the whole pier is unsteady, and until removal a bar will always form between the crib-piers, just to the west. The amount of earth and slabs to be removed is 48,800 cubic yards, which will cost $26,840. The requisite revetment will cost $8,600. The sum of the two amounts will be required for the fiscal year ending June 30, 1873, which is $35,440.

Père Marquette is in the collection district of Michigan. The nearest port of entry is Grand Haven, and the nearest light-house is at Grand Point au Sable. A beacon-light has been erected on south pier.

Abstract of proposals received and opened, May 4, 1871, for furnishing all the requisite materials and doing the work at harbor at Père Marquette, Michigan.

Names of bidders.	Residence.	I.							II.		
		Timber per cubic foot furnished, framed, &c.			Piles per linear foot.		Per cord in work.		Iron per pound, delivered at work.		
		Hemlock.	Pine.	Oak.	Norway pine.	Oak.	Slabs.	Stone.	Drift-bolts.	Screw-bolts.	Washers.
		Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*			*Cts.*	*Cts.*	*Cts.*
Peirce & Whaling	Milwaukee, Wis.								3.75	5.50	4.75
Parkhurst & Wilkinson.	Chicago, Ill.								3.95	4.95	4.95
Hall, Kimbark & Co.	do								4.50	5.75	5.25
Duncan Dewar	Ludington, Mich.	25	25	30	10	15	$2 00	$14 00			
Smith & Nicols*	Detroit, Mich	30	32½	37	15	25	5 00	14 50	6	9	9

* 37½ per foot driven, bid for driving piles, which was rejected as exorbitant.

Abstract of contracts awarded for improvement of harbor at Père Marquette, Michigan.

Contractor.	Nature of contract.	Price.
Duncan Dewar	Hemlock timber, furnished, framed, &c	25 cents per linear foot.
	Pine timber, furnished, framed, &c	25 cents per linear foot.
	Oak timber, furnished, framed, &c.	30 cents per linear foot.
	Norway-pine piles	10 cents per linear foot.
	Oak piles	15 cents per linear foot.
	Slabs delivered in work	$2 per cord.
	Stone delivered in work	$14 per cord.
Peirce & Whaling	Drift-bolts delivered at work	3¾ cents per pound.
	Screw-bolts delivered at work	5½ cents per pound.
	Washers delivered at work	4¾ cents per pound.

Statement of vessels entered and cleared Père Marquette Harbor, showing number, tonnage, crews, and cargoes, from April 13 to June 30, (inclusive,) 1871.

Entered.			Cleared.		
Vessels	number	148	Vessels	number	148
Tonnage	tons	18,064	Tonnage	tons	18,683
Crews	number	895	Crews	do	924
Flour	barrels	315	Lumber	M feet	15,069½
Potatoes	bags	260	Timber	do	369
Oil	barrels	5	Fish	kegs	120
Pork	do	10	Railroad-ties	number	1,200
Butter	kegs	6	Shingles	M	1,640
Do	pounds	800	Laths	do	183
Eggs	barrels	23	Pickets	do	9
Stone	cords	183	Slabs	cords	270
Salt	barrels	8			
Groceries	do	37			
Oats	bushels	1,680			
Hay	tons	10			
Iron	do	6			
Lime	barrels	20			
Merchandise	packages	487			

B 4.

REPORT OF OPERATIONS AT THE HARBOR AT PENTWATER, MICHIGAN.

After due advertising and opening of proposals, August 27, 1870, a contract for furnishing 250 cords of stone was awarded to G. P. Adams & Bro. The work of repairing the south pier was done by hired labor. The work was very expensive, owing to the very uneven settling of the crib substructure.

Proposals were opened May 4, 1871, and contracts were awarded to Pierce & Whaling for iron bolts; and to Messrs. Hurley & Corlett for the remaining materials and all the work of building a pier-head to north pier, and connecting the east end of south pier with the shore, (a breach having been made through the old slab-pier;) and to T. Stewart White for dredging. Under these contracts work has been commenced, and the above described work will be finished during the present season.

The following is the detailed cost of the work:

$328\frac{41}{100}$ cords of stone, at $12 per cord	$3,940 92
102,519 feet, board measure, timber, at $11 per M	1,127 71
18,080 pounds drift-bolts, at 3½ cents per pound	632 80
858 pounds screw-bolts, at 5½ cents per pound	47 19
309 cords of slabs, at $1 50 per cord	463 50
127,274 feet, board measure, timber, framed and put in place, at $17 per M	2,163 65
388½ cubic feet pine timber, at 26 cents per foot	101 05
218 cubic feet oak timber, at 38 cents per foot	82 84
191 piles, driven and capped, at $4 50 per pile	859 50
192 cords of stone, rehandled, at $2 50 per cord	480 00
19 cords of stone, delivered in work, at $13 75 per cord	261 25
188 cubic yards slabs removed, (above water,) at 25 cents per yard	47 00
Labor	2,785 94
Superintendence	853 01
Advertising	109 50
Total	13,955 86

On hand July 1, 1870	$4,302 63
Appropriation approved July 11, 1870	10,000 00
Appropriation approved March 3, 1871	10,000 00
	24,302 63
Less amount covered in Treasury, appropriation, repairs, &c., by act approved July 12, 1870	261 73
	24,040 90
Amount expended during fiscal year ending June 30	13,955 86
Amount on hand July 1, 1871	10,085 04

This balance will be entirely exhausted during the present season.

The condition of this harbor is the worst of any under my charge. The old slab revetments are falling to pieces, allowing a deal of sand to fall into the channel, and much more is blown into it from the neighboring sand-hills. The first troublecan be ended by revetting the channel-way with piles, and the channel much benefited by widening it, as shown in the accompanying sketch in red. On the north side of the channel a large portion of the slab revetment has fallen into the channel. The débris will be removed at once. This side of the channel should also be protected by a new revetment. This work will cost $54,780, which can be profitably expended during the fiscal year ending June 30, 1873.

Pentwater is in the collection district of Michigan, and the nearest port of entry is Grand Haven, sixty miles distant. The nearest lighthouse is at Grand Point au Sable. I append herewith—

1. Abstract of proposals received and opened August 27, 1870.
2. Abstract of proposals received and opened May 4, 1871.
3. Abstract of contracts awarded 1870, 1871.
4. Statement of vessels entered and cleared, &c.
5. Sketch showing condition of work.

I have the honor to be, very respectfully, your obedient servant,

F. U. FARQUHAR,
Captain, United States Engineers.

Abstract of proposals received and opened August 27, 1870, for furnishing stone at Pentwater Harbor, Michigan.

Names of bidders.	Residence.	Stone, per cord.
G. P. Adams & Bro*	Chicago, Illinois	$12 00
John Wilson	Racine, Wisconsin	12 00
Wing & Buckley	Manistee, Michigan	12 23
O. J. Jennings	Syracuse, New York	14 00

*Contract awarded to G. P. Adams & Bro.

Abstract of proposals received and opened May 4, 1871, for furnishing the requisite materials, and doing the work for improving the harbor at Pentwater, Michigan.

Name of bidders.	Residence.	Timber per cubic foot, furnished, &c.			Piles per linear foot.		Per cord, delivered in work.		Driving piles.	Iron per pound, delivered at work.			Rent of dredge.	Number of cubic yards dredgeable to take out and remove per day.
		Hemlock.	Pine.	Oak.	Norway pine.	Oak.	Slabs.	Stone.	Per foot, driven.	Drift-bolts.	Screw-bolts.	Washers.		
		Cents.	*Cents.*	*Cents.*	*Cents.*	*Cents.*			*Cents.*	*Cents.*	*Cents.*	*Cents.*		
Pierce & Whaling	Milwaukee, Wis									3.75	5.50	4.75		
Parkhurst & Wilkinson	Chicago, Ill									3.95	4.95	4.95		
Hall, Kimbark & Co	Chicago, Ill									4	5.75	5.25		
Corlett & Hurly	Pentwater, Mich	24	26	38	10	6	$1 50	$13 75	22					
T. Stewart White	Grand Haven												$94 50	480
Hugh Maher	Chicago												160 00	250

Abstract of contracts awarded for improving harbor at Pentwater, Michigan.

Contractor.	Nature of contract.	Price.
Corlett & Hurly	Hemlock timber, furnished, framed, &c	24 cents per foot.
	Pine timber, furnished, framed, &c	26 cents per foot.
	Oak timber, furnished, framed, &c	38 cents per foot.
	Norway pine piles, per linear foot	10 cents.
	Oak piles, per linear foot	6 cents.
	Slabs	$1 50 per cord.
	Stone	$13 75 per cord.
	Driving piles, per foot driven	22 cents.
Pierce & Whaling	Drift-bolts	3¾ cents per pound.
	Screw-bolts	5½ cents per pound.
	Washers	4¾ cents per pound.
T. Stewart White	Dredging, per day	$94 50.
G. P. Adams & Bro	Stone, per cord	$12 00.

Statement of vessels entered Pentwater Harbor, showing the number, tonnage, crews, and cargoes, during the year 1870.

Vessels	number	373	Potatoes	bushels	60
Tonnage	tons	35,917	Butter	firkins	158
Crews	number	2,081	Flour	barrels	2,347
Pig-iron	tons	30	Feed	bags	1,776
Stone	cords	185	Pork	barrels	672
Plaster	barrels	63	Beef	do	163
Lime	do	288	Hams	pounds	4,000
Brick	M	40	Hay	tons	433
Salt	barrels	157	Live stock	head	60
Oats	bushels	1,800	Fruit, (not specified)	bushels	993
Grain, (not specified)	do	36,324	Merchandise	packages	7,009

Statement of vessels cleared at Pentwater Harbor, showing the number, tonnage, crews, and cargoes, during the year 1870.

Vessels	number	359	Shingles	M	110,121
Tonnage	tons	36,728	Pickets	do	8
Crews	number	1,998	Staves	do	7
Wood	cords	3,596	Grain, (not specified)	bushels	20
Shingle bolts	do	7,047	Potatoes	do	3,710
Staves bolts	do	47	Flour	barrels	15
Bark	do	615	Fish	do	266
Railroad ties	number	21,400	Leather	rolls	20
Lumber	M feet	12,194	Merchandise	packages	271
Lath	M	2,331			

B 5.

REPORT OF OPERATIONS AT THE HARBOR AT WHITE RIVER, MICHIGAN.

During the past year the north pier has been extended 256 feet, and the superstructure completed for the same distance. Beyond this, piles have been driven for a farther distance of 64 feet. The piers built during the fiscal year ending June 30, 1870, have been well filled with slabs, brush, and stone. No pile has been driven less than 15 feet, and the average depth to which piles have been driven is 17 feet. The dredge worked until the close of the season of 1870, when it was laid up, and last spring was sent to Père Marquette. The channel between the piers is now 10 feet deep, except near where the beach intersects the south pier. Here the sand came through, owing to the filling in the pier not settling to the bottom. All the work was done by hired labor. The following is the cost of materials and labor during the past fiscal year:

Cost of repairs of machinery	$3,296 39
Labor on dredging	4,165 28
Labor on pile-driving	2,759 18
Labor on cutting off piles, framing and filling piers	9,908 07
Cost of iron	834 77

Cost of stone	$4,849 84
Cost of timber	2,351 34
Cost of slabs	1,143 46
Cost of piles	1,074 66
Superintendence	486 65
Advertising	68 00
	30,937 64

Amount on hand July 1, 1870	$9,393 38
Appropriation approved July 11, 1870	20,000 00
Appropriation approved March 3, 1871	20,000 00
Received from sale of timber	680 00
Less amount covered in Treasury of appropriation for repairs, &c., by act approved July 12, 1870	5,210 00
	44,863 38
Amount expended during fiscal year	30,937 64
Amount on hand July 1, 1871	13,925 74

During the present season it is proposed to finish both piers as shown in blue on accompanying sketch. This will give each pier a total length of 810 feet beyond the beach line.

It may be that the piers will have to be extended still farther if a bar forms again across the mouth of the channel. To do the dredging still necessary and properly ballasting the piers will require an additional appropriation of $10,000, which can be profitably expended during the fiscal year ending June 30, 1873.

White River is in the district of Michigan, and the nearest port of entry is Grand Haven. The nearest light-house is at Muskegon, twelve miles distant.

Abstract of bids received and opened August 27, 1870, for furnishing stone at White River Harbor, Michigan.

Names of bidders.	Residence.	Stone per cord.
C. Fitzsimons*	Chicago, Ill	$11 90
Wing & Buckley	Manistee, Mich	12 33
O. J. Jennings	Syracuse, N. Y	14 00

* Contract awarded to C. Fitzsimons.

List of vessels entered and cleared White River Harbor, Michigan, showing number, crews, and cargoes, during year 1870.

Entered.		Cleared.	
Vessels ... number	535	Vessels ... number	531
Tonnage ... tons	45,169	Tonnage ... tons	44,689
Crews ... number	2,644	Crews ... number	2,684
Stone ... cords	20	Wood ... cords	1,009
Plaster ... barrels	20	Shingle-bolts ... do	1,546
Lime ... do	247	Bark ... do	508
Brick ... M	110	Railroad-ties ... number	44,336
Salt ... barrels	354	Timber ... M feet	45
Wheat ... bushels	1,300	Lumber ... do	30,363
Oats ... do	18,238	Lath ... M	2,451
Corn ... do	3,375	Shingles ... do	23,043
Flour ... barrels	1,123	Pickets ... do	48
Pork ... do	147	Merchandise ... packages	185
Beef ... do	69		
Hay ... tons	55		
Merchandise ... packages	1,898		

B 6.

REPORT OF OPERATIONS AT THE HARBOR AT MUSKEGON, MICHIGAN.

The superstructure over the cribs built in 1869 was finished last season, and a crib 32 feet by 32 feet was placed as a pier-head to the north pier. Last spring another crib, 32 feet by 32 feet, was placed, extending the north pier 32 feet, and the north and south piers were repaired, and the south pier re-ballasted. Both piers had been seriously damaged by vessels running into them. The cost of the work was as follows:

Labor on framing and repairs of cribs and superstructure, &c.	$6,955 84
Cost of stone	4,059 84
Cost of timber	2,193 55
Cost of iron	494 15
Superintendence	1,121 28
Advertising	205 50
	15,030 16

Amount on hand July 1, 1870	$3,543 80
Appropriation approved July 11, 1870	10,000 00
Appropriation approved March 3, 1871	15,000 00
	28,543 80
Amount expended during fiscal year	15,030 16
Amount on hand July 1, 1871	13,513 64

This harbor is at present in good condition, and no new work is necessary. The slab-piers interior to the crib-piers are fast rotting away, and they should be replaced by pile-piers, thus utilizing the slabs now under water and in place. This work has already been recommended in previous reports, and will cost $28,000; 250 cords of stone are necessary to reballast the north pier, which will cost about $4,000. There will therefore be necessary for the fiscal year ending June 30, 1873, the sum of $18,500.

Muskegon is in the collection district of Michigan, and the nearest port of entry is Grand Haven, twelve miles south. It has a small light-house, with lights of the sixth order.

Abstract of bids received and opened March 31, 1871, *for furnishing stone at Muskegon Harbor, Michigan.*

Names of bidders.	Residence.	Stone per cord.
C. Fitzsimons*	Chicago, Ill	$11 40
Wing & Buckley	Milwaukee, Wis	11 47
I. M. Hill	Racine, Wis	14 00

* Contract awarded to C. Fitzsimons.

Statement of vessels entered and cleared Muskegon Harbor, Michigan, showing number, crews and cargoes during year 1870.

Entered.		Cleared.	
Vessels .... number..	2,226	Vessels .... No..	2,223
Tonnage .... tons..	337,251	Tonnage .... tons..	339,960
Crews .... number..	16,763	Crews .... number..	16,767
Stone .... cords..	91	Wood .... cords..	1,078
Brick .... M..	80	Shingle-bolts .... do....	70
Lime .... barrels..	400	Railroad-ties .... number..	108,930
Wheat .... bushels..	6,000	Timber .... M feet..	10
Oats .... do...	22,340	Lumber .... do...	237,228
Corn .... do....	6,520	Lath .... M..	48,560
Pork .... barrels..	20	Shingles .... do..	9,382
Hay .... tons..	511	Pickets .... do..	327
Merchandise .... packages..	13,503	Peaches .... packages..	935

B 7.

REPORT OF OPERATIONS AT GRAND HAVEN HARBOR, MICHIGAN.

After due advertising and opening of proposals, August 27, 1870, contracts were awarded to Messrs. Peirce & Whaling for iron, to Messrs. G. P. Adams & Bro. for stone, and to T. Stewart White for all the remaining materials, and all the work of repairing the old railroad pier. Under this contract, 200 feet of repairs were completed, and the remaining 400 feet well under way. The detailed cost of the work was as follows:

11,734 feet white-oak piles, at 15 cents per foot	$1,760 10
35,940 feet, board measure, pine timber, at $25 per M	898 50
3,112 feet, board measure, oak timber, at $45 per M	140 04
127.30 cords of stone, at $10 90	1,387 57
30½ cords of stone, at $15	457 50
541.58 cords of slabs, at $2 25	1,218 55
12,294 pounds of drift-bolts, at $3 65 per pound	448 73
787 pounds of screw-bolts, at 4$\frac{7}{10}$ per pound	36 99
Driving piles, 3,829 feet, at 20 cents per foot	765 80
Tearing away 500 feet old work, at $1 75 per foot	875 00
Removing 70,581 cords stone, at $3 per cord	211 74
Superintendence	904 23
Advertising	64 50
Use of scow two days, at $2 50 per day	5 00
Labor	67 00
Total	9,241 25

Amount on hand July 1, 1870	$293 00
Appropriation approved July 12, 1870	10,000 00
Appropriation approved March 3, 1871	6,000 00
	16,293 00
Amount expended during fiscal year	9,241 25
Amount on hand July 1, 1871	7,051 75

During the present season the repairs to the old railroad pier will be completed, which will exhaust the amount on hand.

A pier-head should be built at the end of the present pier, which will cost $7,000.

I would again urge the building of a north pier, which will cost $200,000. Until this pier is built this harbor cannot be made one of refuge.

A great deal of re-ballasting of crib-pier is necessary, and some repairs to the timber work, which will cost about $5,300.

The long revetment interior to the railroad-pier, built in 1867, is in very bad repair, and I fear that a large portion of it will have to be rebuilt. It has been damaged by being used as a dock by vessels, by being run into by vessels not under control, and by being undermined by the current of the river, where it impinges against it.

At present prices the repairs of this interior work (shown on accompanying tracing from A to B) would cost about $36,000. The urgency of the repairs is as great as that which required its building in 1867.

On the accompanying tracing the blue lines show work in progress, and red lines new work recommended under future appropriations.

Abstract of bids received and opened August 27, 1870, for improving harbor at Grand Haven, Michigan.

Names of bidders.	Residence.	Timber furnished, framed, &c., per M, board mea're.		Piles.	Per cord in work.		Iron per pound at work.		Driving piles.	Removing old pier.
		Pine.	Oak.	White oak.	Stone.	Slabs.	Drift-bolts.	Screw-bolts.	Per foot, driven.	Per running foot.
				cts.			*cts.*	*cts.*	*cts.*	
T. Stewart White	Grand Haven, Mich	$25 00	$45 00	15	$11 00	$2 25	4	6.50	20	$1 75
Lewis, Oliver & Phillips	Milwaukee, Wis						3.75	5.25		
Pierce & Whaling	Milwaukee, Wis						3.65	4.70		
G. P. Adams & Bro	Chicago, Ill				10 90					

Abstract of contracts for material and work for improving harbor at Grand Haven, Michigan.

Contractors.	Residence.	Timber furnished framed, &c., per M, board mea're.		Piles.	Driving piles.	Per cord delivered in work.		Iron delivered at work.		Removing old pier.
		Pine.	Oak.	White oak.	Per foot, driven.	Slabs.	Stone.	Drift-bolts.	Screw-bolts.	Per running foot.
				cts.	*cts.*			*cts.*	*cts.*	
T. Stewart White	Grand Haven, Mich	$25 00	$45 00	15	20	$2 25				$1 75
Pierce & Whaling	Milwaukee, Wis							3.65	4.7-10	
G. P. Adams & Bro.	Chicago, Ill						$10 90			

Statement of vessels entered Grand Haven Harbor, Michigan, showing number, tonnage, crews, and cargoes, during the year 1870.

Vessels..........number..	1, 364	Eggs..........dozens..	4, 540
Tonnage..........tons..	493, 087	Flour..........barrels..	125, 396
Crews..........	17, 400	Feed..........bags..	202, 141
Shingles..........M..	5	Pork..........barrels..	31, 860
Staves..........M..	50	Beef..........do....	8, 396
Furniture..........pieces..	3, 100	Hams..........tierces..	869
Railroad-iron..........tons..	3, 809	Lard..........do....	5, 176
Stone..........cords..	341	Hops..........bales..	327
Coal..........tons..	1, 901	Hay..........tons..	393
Plaster..........barrels..	5, 057	Wool..........sacks..	10, 492
Plaster-rock..........tons..	125	Wool..........pounds..	40, 314
Lime..........barrels..	7, 294	Hides..........number..	1, 392
Salt..........do....	11, 145	Live stock..........head..	735
Wheat..........bushels..	107, 561	Fruit-trees..........number..	5, 000
Oats..........do....	95, 828	Apples..........barrels..	21
Corn..........do....	25, 018	Cranberries..........do....	15
Barley..........do....	9, 692	Fish..........do....	160
Rye..........do....	302	Pigeons..........do....	19
Potatoes..........do....	230	Leather..........rolls..	600
Butter..........pounds..	10, 800	Merchandise..........packages..	101, 670

Statement of vessels cleared Grand Haven Harbor, Michigan, showing the number, tonnage, crews, and cargoes, during the year 1870.

Vessels..........number..	1, 400	Cider..........barrels..	49
Tonnage..........tons..	480, 537	Fish..........boxes..	9, 948
Crews..........number..	16, 247	Magnolia water..........case..	1
Wood..........cords..	5, 540	Leather..........rolls..	683
Slabs..........do...	32	Merchandise..........packages..	144, 795
Shingle-bolts..........do...	705	Headings..........barrels..	350
Bark..........do...	1, 283	Wood-bowls..........number..	140
Stave-bolts..........do...	110	Railroad-iron..........tons..	300
Railroad-ties..........number..	52, 627	Castings..........pounds..	1, 400
Spiles..........do...	1, 207	Plaster..........barrels..	20, 583
Fence-posts..........M..	3	Plaster-rock..........tons..	1, 162
Timber..........do...	80	Lime..........barrels..	20
Lumber..........do...	56, 908	Wheat..........bushels..	5, 143
Lath..........do...	1, 623	Potatoes..........do..	11, 759
Shingles..........do...	11, 755	Butter..........pounds..	200
Pickets..........do...	99	Flour..........barrels..	1, 578
Staves..........do...	640	Feed..........bags..	100
Furniture..........pieces..	211	Pork..........barrels..	25
Apples..........barrels..	54, 107	Hams..........do...	130
Grapes..........boxes..	4	Wool..........sacks..	15
Fruit, (not specified)..........barrels..	828	Hides..........number..	91
Do..........packages..	100	Live stock..........head..	133
Berries..........crates..	190		

B 8.

8. REPORT OF THE WORK OF IMPROVING THE HARBOR AT BLACK LAKE, MICHIGAN.

A crib, 32 feet square in plan, was placed last autumn as a pier-head to the north pier. It was only built to the water's surface, and left to properly bed itself during the winter. There was also built 100 feet of crib-work, extending the south pier inward to prevent a breach. By a reference to the accompanying sketch, it will be seen that a further breach is threatened on the south side of the harbor, rendering imperatively necessary the work now being done, (shown in blue.)

The work of first half of fiscal year was done by hired labor. After due advertising and opening of bids on August 27, 1870, contracts were awarded to the lowest bidders, Willard B. Johnson, for furnishing pine timber; John Roost for furnishing stone and slabs, and Messrs. Peirce & Whaling for furnishing iron. On May 5, 1871, after due advertising and opening of bids, contracts were awarded to Messrs. Peirce & Whaling for furnishing the iron, and to Messrs. Uriah Culbert & Co. for furnishing all other materials and all the work. Work during the present season was commenced May 31, and has been confined to driving piles. It was found necessary to employ a dredge for about six days to remove the debris of stone and sand which had fallen into the channel on the south side, in order to properly drive the piles.

The following is a detailed statement of cost of materials and work for the fiscal year:

1,398 linear feet white-oak piles, at 13½ cents per foot	$188 73
4,300 linear feet white-oak piles, at 13 cents per foot	559 00
10,122 cubic feet pine timber, at 14¾ cents per foot	1,492 99
336 feet, board measure, oak timber, at $20 per M	6 72
508 feet, board measure, pine timber, at $12 per M	6 10
435 $\frac{98}{128}$ cords of stone, at $9 90 per cord	4,314 02
232 $\frac{97}{128}$ cords of slabs, at $3 50 per cord	814 62
8,375 pounds of drift-bolts, at 3¾ cents per pound	314 06
1,053 pounds of drift-bolts, at 3.65 cents per pound	38 43
Tools and sundries	120 32
Wood for engine of pile-driver	14 37
Superintendence	722 99
Driving piles, 2,461 feet, at 22 cents per foot	541 42
Advertising	44 84
Use of tug and scow	232 95
Transportation of iron bolts	9 38
Labor	2,009 75
Dredging 58½ hours, at $15 per hour	877 50
Total	12,308 19

Amount on hand July 1, 1870	$494 47
Appropriation approved July 11, 1870	10,000 00
Appropriation approved March 3, 1871	10,000 00
Total	20,494 47
Less amount expended during fiscal year	12,308 19
Amount remaining on hand July 1, 1871	8,186 28

Before the close of navigation the superstructure on the north pier-head, and about 640 feet of channel revetment, will be completed, which will entirely exhaust the amount available for expenditure at this harbor.

The revetment to the channel-way should be finished as soon as practicable. This work is shown in red on the accompanying tracing. To do this 850 feet of close piling in addition to what is now under course of construction will be required, which will cost $12,500. Unless this work is done great damage may result. Black Lake Harbor is in the district of Michigan. There has been a pier light erected there during the past year.

Abstract of bids opened and received August 27, 1870, for improving harbor at Black Lake, Michigan.

Names of bidders.	Residence.	Stone, per cord.	Iron, per pound.	Slabs, per cord.	12 by 12 inch timber, per cubic foot.
John Roost	Holland, Mich	$9 90		$3 50	$0 16⅞
Peirce & Whaling	Milwaukee, Wis		$0 3¾		
Willard B. Johnson	do				14⅞
Jan Aling	Holland, Mich	10 90			
G. P. Adams & Bro	Chicago, Ill	10 90			

Abstract of contracts awarded for improving harbor at Black Lake, Michigan.

Contractor.	Nature of contract.	Price.
John Roost	Stone	$9 90 per cord.
Peirce & Whaling	Iron bolts	3¾ cents per pound.
Willard B. Johnson	12 by 12-inch timber	14⅞ cents per cubic foot.

Abstract of proposals received and opened May 4, 1871, for furnishing the requisite material and doing the work of improving the harbor at Black Lake, Michigan.

Names of bidders.	Residence.	Piles per linear foot.			Timber per linear foot, furnished, framed, &c.			Driving piles.	Per cord, delivered in work.		Iron delivered at work.		
		White oak.	Beech.	Hemlock.	12 by 12-inch pine.	10 by 12-inch oak.	4 by 8-inch oak.	Per foot, driven.	Stone.	Slabs.	Drift-bolts.	Screw-bolts.	Washers.
		Cts.	Cts.	Cts.	Cts.	Cts.	Cts.				Cts.	Cts.	Cts.
Peirce & Whaling	Milwaukee, Wis										3¾	5½	4¾
Parkhurst & Wilkinson	Chicago, Ill										3. 95	4. 95	4. 95
Hall, Kimbark & Co	do										4½	5¾	5¼
T. F. Tebel	Milwaukee, Wis	14	10	8	26	29	32	$1 75* 2 25†	$9 80	$3 25	4⅝	6¼	6½
W. Culbert & Co	Muskegon, Mich	13			27	31	21	22	9 75	3 25	7	7	7
John Roost	Holland, Mich	14	12	9	28	32	22	24	9 50	3 50	7¼	7¼	7¼
Smith & Nicolls	Detroit, Mich	37½		15	32½	37½	37½	37½	12 50	4 50	6	9½	9½

* Land. † Water.

Abstract of contracts awarded for improvement of harbor at Black Lake, Michigan.

Contractor.	Nature of contract.	Price.
W. Culbert & Co	White-oak piles	13 cents per linear foot.
Do	12 by 12 inches pine timber furnished, framed, &c	27 cents per linear foot.
Do	10 by 12 inches oak timber, furnished, framed, &c.	31 cents per linear foot.
Do	4 by 8 inches ......do..........do..........do	21 cents per linear foot.
Do	Driving piles, per foot driven	22 cents.
Do	Stone, delivered in work	$9 75 per cord.
Do	Slabs, delivered in work	$3 25 per cord.
Pierce & Whaling	Drift-bolts, delivered at work	3¾ cents per pound.
Do	Screw-bolts, delivered at work	5½ cents per pound.
Do	Washers, delivered at work	4¾ cents per pound.

Statement of vessels entered and cleared at Black Lake Harbor, (Holland, Michigan,) in the district of Michigan, showing the number, tonnage, crews, and cargoes during the year.

Entered.		Cleared.	
Vessels .... number..	445	Vessels .... number..	435
Tonnage .... tons..	32, 277	Tonnage .... tons..	34, 861
Crews .... number..	2, 199	Crews .... number..	2, 153
Wagons .... do....	5	Wood .... cords..	8, 449
Railroad iron .... tons..	19	Bark .... do...	2, 431
Coal .... do...	37	Railroad ties .... number..	26, 809
Plaster .... barrels..	6	Lumber .... M feet..	3, 047
Lime .... do....	751	Shingles .... M..	60
Brick .... M..	6	Staves .... M..	2, 698
Salt .... barrels..	918	Heading .... barrels..	4, 811
Oats .... bushels..	540	Iron ore .... tons..	1
Corn .... do....	590	Salt .... barrels..	25
Flour .... barrels..	12	Barley .... pounds..	23, 275
Meal .... pounds..	4, 000	Potatoes .... bushels..	5, 490
Pork .... barrels..	3	Butter .... pounds..	17, 998
Hides .... number..	577	Eggs .... dozen..	8, 540
Vegetables .... packages..	500	Flour .... barrels..	2, 677
Merchandise .... do....	9, 343	Berries (not specified) .... bushels..	70
		Fish .... barrels..	12
		Leather .... rolls..	987
		Merchandise .... packages..	1, 410

B 9.

REPORT OF THE WORK FOR IMPROVING THE HARBOR AT SAUGATUCK, MICHIGAN.

The revetment on left bank of Kalamazoo River has been completed as far as the east end of slab-pier. The work is substantial and has already proved of signal service in deepening the channel. (On accompanying tracing the black figures give depth of water before building of revetment and red figures the depth found on opening of navigation.) The detailed cost of the work was as follows:

20,429$\frac{9}{10}$ linear feet white-oak piles, at 13 cents	$2, 655 89
610 linear feet beech piles, at 10 cents	61 10
15,557$\frac{3}{4}$ linear feet hemlock piles, at 8 cents	1, 244 62
64,704 feet, board measure, pine timber, at $11 50 per M..	744 09
1,920 feet, board measure, pine timber, at $10 per M	19 20
12,071$\frac{1}{4}$ feet, board measure, oak timber, at $16 per M.....	193 14
2,543$\frac{2}{10}$ cords of slabs, at $1 90 per cord	4, 832 08
490$\frac{492}{1000}$ cords of stone, at $10 per cord	4, 904 92
12 cords of facines, at $2 10 per cord	25 20
8,432 pounds of drift-bolts, at 3$\frac{1}{4}$ cents per pound	274 04
Driving 1,770 piles, at $2 per pile	3, 540 00
Framing 15,028 feet of timber, at 13 cents per foot	1, 953 64
Freight, dockage, and storage of drift-bolts	23 25
Tug-hire	155 00
Advertising	64 00
Labor	12 81
Superintendence	1, 997 44
Total	$22, 700 42

Amount on hand July 1, 1870	$16, 774 43
Allotted during fiscal year from appropriation for repairs preservation, &c	662 31

Appropriation approved July 1, 1870	$10,000 00
Appropriation approved March 3, 1871	10,000 00
Total	37,436 74
Less amount expended during fiscal year	22,700 42
Amount on hand July 1, 1871	14,736 32

After due advertisement and opening of proposals, May 4, 1871, contracts were awarded to Parkhurst & Wilkinson for iron, and to F. L. Tebel for all the remaining materials and all the work of protecting the slab-pier on south side of entrance to the river. The work is now under construction and it is hoped that it will be finished by November 1, 1871. The blue lines on accompanying tracing show the rows of protecting piles. The recommendation made in my last report for a north pier and necessary revetment at mouth of river is renewed. This work will cost $59,300 98, and this amount can be profitably expended during the fiscal year ending June 30, 1873.

Saugatuck is in the district of Michigan. There is a light-house, with lantern of sixth order, on the north side of the harbor.

Abstract of proposals received and opened May 4, 1871, *for furnishing the requisite materials and doing the work for improving the harbor at Saugatuck, Michigan.*

Names of bidders.	Residence.	Piles per linear foot.			Timber per foot.*			Stone, per cord, in work.	Driving piles, per foot, driven.	Iron per lb., delivered at work.			Slabs, per cord.
		White oak.	Beech.	Hemlock.	12 by 12 inch pine.	10 by 12-inch oak.	4 by 8-inch oak.			Drift-bolts.	Screw-bolts.	Washers.	
		Cts.	*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*			*Cts.*	*Cts.*	*Cts.*	
Peirce & Whaling	Milwaukee, Wis									3¾	5¼	4¾	
Parkhurst & Wilkinson	Chicago, Ill									(†)	(‡)	(‡)	
Hall, Kimbark & Co§	do									4½	5½	5¼	
F. L. Tebel	Milwaukee, Wis	12	10	8	25	29	32	$10 00	$2 00‖	4⅝	6½	6¼	§$2 50
Uriah Culbert & Co	Muskegon, Mich	13	12	9	27	31	21	9 75	22	7	7	7	2 50
John Roost	Holland, Mich	14	12	9	28	32	22	9 90	24	7¼	7¼	7½	2 50

* Furnished, framed, &c. †3 9-10 cents. ‡4 9-10 cents. § Slabs not canvassed, as few, if any, will be used. ‖ Each.

Abstract of contracts awarded for improvement of harbor at Saugatuck, Michigan.

Contractor.	Nature of contract.	Price.
F. L. Tebel	White-oak piles	12 cents per linear foot.
Do	Beech piles	10 cents per linear foot.
Do	Hemlock piles	8 cents per linear foot.
Do	12 by 12 inch pine timber, furnished, framed, &c	25 cents per linear foot.
Do	10 by 12 inch oak timber, furnished, framed, &c	29 cents per linear foot.
Do	4 by 8 inch oak timber, furnished, framed, &c	32 cents per linear foot.
Do	Stone, delivered in work	$10 per cord.
Do	Slabs, delivered in work	$2 50 per cord.
Do	Driving piles	$2 each.
Parkhurst & Wilkinson	Drift-bolts, delivered at work	3 9-10ths cents per pound.
Do	Screw-bolts, delivered at work	4 9-10ths cents per pound.
Do	Washers, delivered at work	4 9-10ths cents per pound.

Statement of vessels entered and cleared at Saugatuck Harbor, in the district of Michigan, showing the number of vessels, tonnage, crews, and cargoes, during the year 1870.

Entered.		Cleared.	
Vessels……number..	729	Vessels……number..	796
Tonnage……tons..	81, 995	Tonnage……tons..	83, 917
Crews……number..	4, 926	Crews……number..	4, 900
Lumber……M feet..	157	Wood……cords..	10, 192
Shingles……M..	650	Bark……do…	817
Coal……hhds..	10	Railroad-ties……number..	23, 400
Plaster……bbls..	50	Lumber……M feet..	37, 067
Lime……do…	190	Lath……M..	1, 593
Salt……do…	30	Shingles……M..	30, 080
Wheat……bushels..	100	Pickets……M..	161
Grain, not specified……do…	8, 584	Staves……M..	65
Flour……bbls..	433	Potatoes……bushels .	7, 870
Feed……bags..	81	Flour……bbls..	285
Pork……bbls..	40	Apples……bushels..	300
Hay……tons..	51	Vegetables……pkgs..	18
Hides……No..	17, 306	Fish……do…	215
Merchandise……pkgs..	3, 843	Leather……pounds..	714, 150

B 10.

REPORT OF OPERATIONS AT THE HARBOR AT SOUTH HAVEN, MICHIGAN.

After due advertising and opening of proposals September 4, 1870, contracts were awarded to George Hannahs for furnishing timber, and to G. P. Adams & Brother for furnishing stone.

By hired labor there was built a 30-foot square crib, which was placed on the extension of the north pier. The north pier, which had settled very irregularly, was also leveled up. This work was done during the months of September, October, and November of 1870.

After due advertising and opening of proposals, contracts were, May 15, 1871, awarded to Messrs. Peirce & Whaling for iron, and to George Hannahs for the remaining materials and all the work. Under this contract, one crib 50 feet by 32 feet was placed on the extension of the south pier during the last fiscal year. The detailed cost of the work was as follows:

62,128 feet, board measure pine timber, at $14 50 per M….	$900	86
5,128 cubic feet hemlock timber, at 29½ cents per foot……	1,512	76
$280\frac{21}{128}$ cords of stone, at $10 23……	2, 866	07
$104\frac{67}{128}$ cords of stone, at $11……	1, 149	75
26 cords of stone, at $11 25……	292	50
$7,458\frac{84}{100}$ pounds of drift-bolts, at 3¾ cents per pound……	279	71
$1,122\frac{58}{100}$ pounds of screw-bolts, at 5½ cents per pound……	56	24
$552\frac{24}{100}$ pounds of washers, at 4¾ cents per pound……	26	23
390 pounds of rope, at 15⅓ cents per pound……	59	80
Use of tug and scow……	104	00
Tools, iron, &c……	57	47
Advertising……	121	00
Labor……	617	32
Superintendence……	667	41
Transportation……	1	00
	8, 712	12

Amount on hand July 1, 1870	$188 12
Appropriation approved July 11, 1870	10,000 00
Appropriation approved March 3, 1871	15,000 00
	25,188 12
Less amount expended during fiscal year	8,712 12
Amount on hand July 1, 1871	16,476 00

During the present season three cribs, 50 feet by 32 feet, will be placed—two on the extension of the north pier, and one on the south pier. This work, and the expense of re-ballasting both piers, will entirely exhaust the unexpended balance.

I would recommend no further extension of either pier, at present, beyond what is now under contract.

The old slab and brush piers, interior to the work constructed by the Government, are in a very bad condition. They are very much decayed, and a good deal of sand comes through them, particularly from the north side of the channel. In lieu of the plans already recommended, I would propose the widening of the channel, by dredging out the north bank as shown in red on the accompanying tracing, and constructing a pile revetment. The channel-way should also be deepened to 12 feet of water. The dredging will cost $32,000, and the pile revetment will cost $12,138 33.

On the accompanying tracing, work now in progress and to be finished this season is shown in blue, and work recommended is shown in red.

South Haven is in the district of Michigan, and the nearest light-house is at Saugatuck, Mich.

Abstract of proposals received and opened September 4, 1870, *for furnishing materials at the harbor at South Haven, Michigan.*

Names of bidders.	Residence.	Timber, per M, board measure.	Stone, per cord.	Drift-bolts, per pound.	Screw-bolts, per pound.
				Cts.	*Cts.*
Lewis, Oliver & Phillips	Milwaukee, Wis			3½	5¼
Peirce & Whaling	do			3¼	
G. P. Adams & Co	Chicago, Ill		$10 23		
George Hannahs	South Haven, Mich	$14 50			

NOTE.—No contract for bolts was awarded, as none were needed.

Abstract of contracts awarded, 1870, *for furnishing materials at the harbor at South Haven, Michigan.*

Contractor.	Residence.	Timber, per M, board measure.	Stone, per cord.
George Hannahs	South Haven, Mich	$14 50	
G. P. Adams & Brother	Chicago, Ill		$10 23

Abstract of proposals received and opened May 15, 1871, *for furnishing the requisite materials and doing the work for improvement of harbor at South Haven, Michigan.*

Names of bidders.	Residence.	Timber furnished, framed, and put in place.			Stone, per cord.	Iron per pound, delivered at work.			Slabs, per cord.
		12 by 18-inch hemlock.	12 by 12-inch hemlock.	Pine.		Drift-bolts.	Screw-bolts.	Washers.	
		Cts.	*Cts.*	*Cts.*	*Dolls.*	*Cts.*	*Cts.*	*Cts.*	*Dolls.*
Peirce & Whaling	Milwaukee, Wis	......	......	......	......	3¾	5¼	4½	......
Hall, Kimbark & Co	Chicago, Ill	......	......	......	......	4¼	5½	5¼	......
George Hannahs*	South Haven, Mich	29¼	29¼	29½	11 00	4 4-10	5¼	5¼	3 25
Samuel G. Hartt†	Fulton, N. Y	26	26	30	12 00	6	7	7	......
Smith and Nicolls‡	Detroit, Mich	29¼	28½	29½	12 50	4¾	7	4½	......

* Few, if any, slabs will be used. † T. Stewart White bid for dredging, $115 per day.
‡ No dredging will be required.

Abstract of contracts awarded for improvement of harbor at South Haven, Michigan.

Contractors.	Nature of contract.	Price.
George Hannahs	12 by 18-inch hemlock timber, furnished, framed, &c.	29¼ cents per cubic foot.
Do	12 by 12-inch hemlock timber, furnished, framed, &c.	29¼ cents per cubic foot.
Do	Pine timber, furnished, framed, &c	29½ cents per cubic foot.
Do	Stone, delivered in work	$11 per cord.
Do	Slabs, delivered in work	$3 25 per cord.
Peirce & Whaling	Drift-bolts, delivered at work	3¾ cents per pound.
Do	Screw-bolts, delivered at work	5¼ cents per pound.
Do	Washers, delivered at work	4½ cents per pound.

Statement of vessels entered and cleared, South Haven Harbor, Michigan, showing number, tonnage, crews, and cargoes, during the year 1870.

Entered.			Cleared.		
Vessels	number	452	Vessels	number	464
Tonnage	tons	31, 611	Tonnage	tons	32, 244
Crews	number	2, 157	Crew	number	2, 172
Stone	cords	280	Wood	cords	13, 721
Coal	tons	37	Bark	do	4, 521
Lime	barrels	160	Railroad ties	number	3, 400
Salt	do	329	Timber	M feet	342
Wheat	bushels	1, 700	Lumber	do	5, 564
Corn	do	1, 108	Lath	M	175
Grain (not specified)	do	722	Shingles	M	1, 730
Butter	pounds	200	Apples	bushels	965
Flour	barrels	901	Peaches	baskets	275
Feed	bags	1, 014	Leather	rolls	70
Pork	barrels	40	Merchandise	packages	256
Hay	tons	46			
Merchandise	packages	2, 028			

B 11.

REPORT OF OPERATIONS AT THE HARBOR AT ST. JOSEPH, MICHIGAN.

As soon after the passage of the act approved July 11, 1870, making an appropriation for the improvement of this harbor, as was possible, advertisement was made, inviting proposals for extending the south pier, and on September 6, 1870, contracts were awarded to the lowest bidders—R. A. Conolly, for furnishing timber, piles, and slabs, and *doing all the* work; Charles Fitzsimmons, for furnishing stone, and

Messrs. Peirce & Whaling for furnishing iron. (See abstract of contracts below.)

The contractor for furnishing timber and piles could do nothing more, owing to the lateness of the season, than to get out materials in readiness for the work during this season.

The following is the amount of materials furnished and work done, together with the cost:

1,190⅔ feet, board measure, oak timber, at 39 dollars per thousand	$46 43
12,703 feet white-oak piles, at 14 cents per foot	1,778 42
9,453 pounds of drift-bolts, at 3¾ cents per pound	279 49
5,158 pounds of screw-bolts, at 4.8 cents per pound	247 58
30¼ cords of stone, at $10 45	316 11
112 cords of slabs, at $2 83	316 96
One small boat	43 00
For driving piles, 5,398½ feet, at 22 cents per foot	1,187 67
For superintendence	1,113 83
For advertising	122 50
Total	5,451 99

On hand July 1, 1870	$383 26
Appropriation approved July 11, 1870	15,000 00
Appropriation approved March 3, 1871	10,000 00
Total	25,383 26
Less amount expended during fiscal year	5,451 99
Amount remaining on hand July 1, 1871	19,931 27

After due advertising and opening of proposals, a contract was awarded, May 11, 1871, to R. A. Conolly for furnishing all the materials (except iron) and all the work, and to Messrs. Parkhurst & Wilkinson for iron, under the appropriation approved March 3, 1871. (See abstract of contracts awarded, at end of report.) Under this contract no work has yet been done.

The amount available, together with the work already done, will extend the north pier 450 feet. This work will be finished by November 1, 1871.

There will be necessary some refilling of both north and south piers next season, together with some probable repairs, which will cost about $3,000. I think no new work is necessary at present.

I would again call attention to the position of the railroad bridge, which renders this harbor useless as one of refuge. Its position is shown on the accompanying tracing. The pier in blue shows work in progress and to be finished this year. The figures on other portions of piers show dates of construction.

St. Joseph is in the district of Michigan. There is a light-house on keeper's dwelling of sixth order, and also a pier-light on end of finished south pier, which light was built last autumn.

I have the honor to be, very respectfully, your obedient servant,

F. U. FARQUHAR,
Captain United States Engineers.

Brig. Gen. A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

Abstract of bids received and opened August 27, 1870, *for improving harbor at St. Joseph, Michigan.*

Names of bidders.	Residence.	Timber, per M, board measure.		Piles, per linear foot.	Driving piles, per foot driven.	Framing, pr. M, board measure.		Per cord, 128 cubic feet.		Iron per pound.	
		Pine.	Oak.			Pine.	Oak.	Stone.	Slabs.	Drift-bolts.	Screw-bolts.
R. A. Conolly	Chicago, Ill	$14 30	$16	14c.	22c.	$13 30	$23	$11 25	$2 83	3¾c	5¼c.
Lewis, Oliver & Phillips.	Milwaukee, Wis									3¾c.	5¼c.
E. Fitzsimmons	Chicago, Ill							10 45			
Peirce & Whaling	Milwaukee, Wis.									3¾c.	4.8c.
C. Boughton*		18†	20c†	16c.	50c.			13 00	2 50	8c.	10c.

* Informal, and not considered. † Per foot.

Abstract of contracts awarded for improving harbor at St. Joseph, Michigan, September, 1870.

Contractor.	Nature of contract.	Price.
R. A. Conolly	For white-oak piles	14 cents per linear foot.
Do	For pine timber, furnishing, framing, &c	$27 60 per M, board measure.
Do	For oak timber, furnishing, framing, &c	$39 per M, board measure.
Do	For driving piles, per foot driven	22 cents.
Do	For slabs, furnished and put in place	$2 83 per cord.
Peirce & Whaling	For drift-bolts, delivered at work	3¾ cents per pound.
Do	For screw-bolts, delivered at work	4.8 cents per pound.
Do	For washers, delivered at work	4.8 cents per pound.
Chas. Fitzsimmons	For stone, delivered at work	$10 45.

Abstract of proposals received and opened May 6, 1871, *for furnishing the requisite materials and doing the work for improvement of harbor at St. Joseph, Michigan.*

Names of bidders.	Residence.	I.							II.		
		Timber, furnished, framed, &c.			White-oak piles, per linear foot.	Per cord, delivered in work.		Driving piles, per foot driven.	Iron, per pound, delivered at work.		
		12 by 12 inch pine.	4 by 8 inch oak.	10 by 12 inch oak.		Stone.	Slabs.		Drift bolts.	Screw-bolts.	Washers.
		Cts.	Cts.	Cts.	Cts.				Cts.	Cts.	Cts.
Parkhurst & Wilkinson.	Chicago, Ill								3.9	4.9	4.9
Peirce & Whaling	Milwaukee, Wis								3¾	5¼	4¾
Hall, Kimbark & Co	Chicago, Ill								4⅓	5¾	5¼
Pratt & Co	Buffalo, N. Y								4½	6½	6½
R. A. Conolly	Chicago, Ill	40	45	45	16	$12	$3 25	26	5⅓	6¾	6¾
Uriah Culbert & Co	Muskegon, Mich.	31	26	35	16	10	4 25	25	7	7	7

Abstract of contracts awarded for improvement of harbor at St. Joseph, Michigan, May, 1871.

Contractor.	Nature of contract.	Price.
R. A. Conolly	12 by 12 inch pine timber, furnished, framed, &c	40 cents per linear foot.
Do	10 by 12 inch oak timber, furnished, framed, &c	45 cents per linear foot.
Do	4 by 8 inch oak timber, furnished, framed, &c	45 cents per linear foot.
Do	White-oak piles	16 cents per linear foot.
Do	Stone, delivered in work	$12 per cord.
Do	Slabs, delivered in work	$3 25 per cord.
Do	Driving piles, per foot driven	26 cents.
Parkhurst & Wilkinson	Drift-bolts, delivered at work	3.9 cents per pound.
Do	Screw-bolts, delivered at work	4.9 cents per pound.
Do	Washers, delivered at work	4.9 cents per pound.

Statement of vessels entered and cleared at St. Joseph's Harbor, in the district of Michigan, showing the number, tonnage, crews, and cargoes during the year 1870.

Entered.		Cleared.	
Vessels .... number..	665	Vessels .... number..	676
Tonnage .... tons..	164, 023	Tonnage .... tons..	165, 923
Crews .... number..	8, 366	Crews .... number..	8, 918
Lumber .... M feet..	1, 311	Wood .... cords..	2, 373
Lath .... M..	230	Railroad-ties .... number..	24, 425
Shingles .... M..	841	Lumber .... M feet..	7, 206
Stone .... cords..	190	Potatoes .... bushels..	10, 571
Coal .... tons..	112	Flour .... barrels..	1, 575
Plaster .... barrels..	870	Apples .... do....	6, 254
Lime .... do....	4, 927	Apples .... bushels..	5, 414
Brick .... M..	67	Fruit, (not specified) .... packages..	6, 990
Grain, (not specified) .... bushels..	8, 584	Strawberries .... bushels..	5, 235
Flour .... barrels..	433	Berries, (not specified) .... do....	15, 999
Feed .... bags..	81	Cider .... barrels..	2
Pork .... barrels..	40	Vegetables .... packages..	5, 517
Merchandise .... packages..	45, 813	Fish .... boxes..	3, 408
Salt .... barrels..	1, 179	Merchandise .... packages..	12, 885

B 12.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, December, 1870.

GENERAL: I have the honor to report that, in compliance with letter dated Office of the Chief of Engineers, Washington, D. C., July 23, 1870, I caused a survey to be made of the harbor at Alpena, Michigan, and would respectfully submit the following report, together with one tracing showing condition of harbor before any work of improvement had been made, and one tracing showing present condition of the harbor, together with a plan for its improvement.

Alpena is situated in Alpena County, Michigan, and at the mouth of Thunder Bay River. Thunder Bay River empties into the bay of the same name, situated on the west shore of Lake Huron.

The business of this place consists principally in manufacturing and shipping lumber. This business is of considerable importance, as may be seen by the accompanying table of exports.

Thunder Bay is an excellent natural harbor of refuge, and is much used as such by passing vessels during easterly storms, and no necessity exists for any improvements, as far as the general commerce of the lakes is concerned.

The condition of the mouth of the river before any improvements had been made is shown on the accompanying tracing of Thunder Bay, made in the office of the United States Lake Survey. By it will be seen that there was a depth of water of 7 feet over the bar, and more inside the mouth of the river. In 1865 the legislature of Michigan chartered the Alpena Harbor Improvement Company. This company took possession of the mouth of Thunder Bay River, and improved it by building piers and dredging. The piers are founded on cribs built of round timber, sunk with stone, and a superstructure of slabs. I have been informed that the amount expended by the company was about $40,000.

These improvements and the present condition of the harbor is shown on the accompanying tracing, made from the survey ordered by act of Congress approved July 11, 1870. At present the harbor facilities are ample. It may be questioned whether, for even local purposes, the improvements made were economical.

The only storms that affect at all the vessels lying at the bridge pier just south of the entrance to the river, are from the southeast and east.

During the season of navigation of 1867, only thirty times did the wind blow from the east hard enough to make a sea at the mouth of the river, and of these thirty storms only twelve lasted during a day, so that, as a rule, vessels could load and unload at piers built out into the bay.

I inclose herewith a "notice to masters of vessels," published by the Alpena Harbor Improvement Company, in which are stated the tonnage dues, &c., to be collected from all vessels drawing over 4 feet of water. Before any improvement should be made by the United States some arrangement should be made with reference to the rights and claims of the company.

If it should be deemed necessary to improve this harbor I would propose the carrying out of the north pier 803 feet, and filling up the gap in the south pier, and a pier-head crib at the end of it. The piers to consist of crib-work, 20 feet wide, except the pier-head, which will be 32 feet wide.

The proposed improvements are shown in red on accompanying tracing. The following would be the probable cost of the work:

For 88,962½ cubic feet pine timber, at 14 cents per foot....	$12,454 75
For 88,962½ cubic feet pine timber framing, at 15 cents per foot....	13,344 37
For 2,025 cords of stone, at $9 per cord....	18,225 00
For 110,100 pounds iron drift-bolts, at 4 cents per pound ..	4,404 00
For 3,152 pounds iron screw-bolts, at 6½ cents per pound...	204 88
	48,633 00
Add 10 per cent. for superintendence and contingencies....	4,863 30
	53,496 30

This estimate may be increased for dredging. No estimate for dredging is now made, as it is hoped that when the piers are carried out the shallow places alongside of the piers will be scoured out by the current of the river.

Alpena is the collection district of Port Huron; nearest light-house is on Thunder Bay Island.

Report of the exports from the port of Alpena, Alpena County, Michigan, as shown by the books in the custom-house office at said port, commencing May 1, 1870, *ending September* 30, 1870.

Months.	Lumber.	Lath.	Shingles.	Fish.	Posts.	Pickets.	Bolts.
	Feet.	*Nos.*	*Nos.*	*Packages.*	*Nos.*	*Nos.*	*Cords.*
May	4,648,590	805,600	2,009,500				
June	7,634,146	1,705,000	6,869,500	70	1,271	6,240	32
July	5,151,509	2,091,000	8,466,000	169	5,180	8,600	65
August	9,025,229	2,740,000	9,637,000	971	2,599	36,690	
September	6,079,000	2,665,400	5,800,000	550			
Total	32,538,474	10,007,000	32,782,000	1,760	9,050	51,530	97

I have the honor to be, very respectfully, your obedient servant,

F. U. FARQUHAR,
Captain Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

B 13.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, November 11, 1870.

GENERAL: I have the honor to acknowledge the receipt of letter dated Office of the Chief of Engineers, Washington, D. C., September 20, 1870, directing me to make such an examination or survey (if necessary) of Mackinaw City, Michigan, as would enable me to make a project and probable estimate of cost of a breakwater, or whatever other works that may be required, to make a harbor of refuge in the vicinity of Mackinaw City.

I would respectfully report that I have made a careful examination of the accurate maps furnished by the lake survey, which furnish sufficient data in this case for any required estimates.

Mackinaw City is situated at the most northerly point of the southern peninsula of the State of Michigan, and is near the west end of the Straits of Mackinaw. At present the city consists of a few houses, the local business consisting, for the most part, of supplying passing vessels with wood and shipping the same. For the predicted (by the owner of the land thereabouts) future, I refer you to the accompanying memoir and maps.

At present there is not local importance enough to justify any expenditure of public funds in building a harbor of any kind.

By an examination of the accompanying general map of the Straits of Mackinaw, it will be seen that there is not the slightest necessity of a harbor of refuge at this point. A vessel can find a harbor of refuge from any storm in one of the many harbors furnished by nature within a few miles of Mackinaw City, from a northeast storm, either behind Bois Blanc Island or McGulpin's Point; from a southeast gale, on the west side of Mackinaw City or McGulpin's Point; from westerly gales, just east of Mackinaw City; and from northerly storms, behind Bois Blanc Island.

Indeed, the Straits of Mackinaw is abundantly provided with refuges for vessels in stress of weather, and if vessels cannot make their natural harbors, much less could they find their way behind a breakwater. In addition, there is along the south coast of the straits excellent anchorage ground. From inquiry, I have learned that the principal disasters to vessels in this locality have happened during foggy weather, or during gales accompanied by snow-storms.

At present there is a crib-dock or pier constructed at Mackinaw City on the east side. This is shown on the owner's map, which is inclosed. On the same map is shown a rough delineation of the proposed or desired breakwater, as the owner of the land thinks is necessary Three miles of breakwater is proposed. This breakwater should be 35 feet wide and about 40 feet high, and would probably cost $3,369,875.

Should the local importance of Mackinaw City ever justify the building of breakwaters in order to protect shipping lying there, they should be built in the bay to the east of the point, be far enough from shore to allow of vessels "coming to" behind them, and should be placed so as to obstruct as little as possible the littoral currents. I have sketched on the accompanying tracing the place for such breakwater. It would be composed of two arms, each 2,000 feet long, 35 feet wide, and averaging about 30 feet high. This work would cost about $761,333 76. The items being as follows:

793,680 linear feet pine timber, (furnished, framed, bolted, and cribs placed,) at 40 cents per foot	$317,472 00
1,374,240 pounds of iron bolts, at 4 cents per pound	54,969 60
26,640 cords of stone, at $12 per cord	319,680 00
	692,121 60
For contingencies, add 10 per cent	69,212 16
Total	761,333 76

The estimate for timber may seem high, but it must be considered that the re-handling of much stone, and great inconveniences from the remoteness of the place, will make labor expensive. After the proposed system of light-houses are built, there can be no necessity for any artificial harbors in the straits of Mackinaw, as far as the general commerce of the lakes is concerned.

I have the honor to be, very respectfully, your obedient servant,

F. U. FARQUHAR,
Captain Corps of Engineers United States Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers United States Army, Washington, D. C.

APPENDIX C 1.

Report of operations at the improvement of St. Mary's Falls Canal and St. Mary's River for the fiscal year ending June 30, 1871.

Though the subject of awarding the contract for the removal of boulders from the St. Mary's River, and of the submission and approval of a project for improving the canal, was briefly referred to in my last annual report dated October 14, 1870, I include herein, in order to make this report complete, a history of the improvements from the commencement of the fiscal year.

An act of Congress approved July 11, 1870, appropriated the sum of $150,000 for the improvement of the St. Mary's Falls Canal and St. Mary's River, notice of which was received from the Chief of Engineers, under date of the 18th of July, 1870, with instructions to prepare and submit a project of operations thereunder. In partial compliance therewith I submitted a report, with form of advertisement inviting proposals for the removal of boulders endangering the navigation of the river St. Mary's, and for improving the west channel of East Neebish Rapids, St. Mary's River, but subsequently receiving assurances that the object of the appropriation was to furnish the means of enlarging the prism of the canal *above* the locks, it was suggested to the Chief of Engineers, on the 11th of August, 1870, that if the case was so understood by him to disapprove the project submitted; recommending at the same time that the work of making a prism of given dimensions and character, with a view to its connection with a new channel and locks alongside those now in use, be let by contract in the usual manner.

Receiving instructions from the Chief of Engineers directing that the project for operations upon the west channel of the East Neebish Rapids be deferred, and the advertisement for the removal of the boulder rocks in the St. Mary's River be published as proposed, the publication of the advertisements was made accordingly, and the proposals offered opened on the 9th of September. The bid of W. W. and E. T. Williams to do the work for $4,800, being the lowest, was accepted, and the contract awarded them for the execution of the work. By the terms of the contract the contractors were to furnish all appliances and do all the work of removing obstructions in accordance with specifications. The work to be commenced on or before the 1st day of October, and completed on or before the 1st day of December, 1870.

No accurate surveys having been made at any of the localities specified, except at the point near the head of Rains Island, it was found at some points that the work required to effect the desired improvements largely exceeded the amount anticipated.

The first four obstructions consisted of boulders and earth, and were removed by dredging. The fifth was a ledge of limestone rock lying in its natural bed, and was blasted and the pieces removed by a diver.

Operations by the contractors were commenced promptly at the three localities below the canal, and on the 15th of October an inspection of the work at the last two points specified revealed the fact that the least water on the area dredged near the head of Rains Island was 13½ feet, and on the obstruction near the lower end of the island, 16 feet and 2 inches. Two days subsequently a further inspection of the work, two and one-fourth miles below the canal, showed a least depth of 16 feet; the water being in each case a few inches lower than in September.

These results being reported to me I directed the resumption of the work at the point near the head of Rains Island. This shoal was found to be of larger extent than had been supposed, and much more work was finally done than had been contemplated when the contract was executed. A further inspection of this locality was made November 23, (the dredge having been employed there nearly two weeks after the receipt of my order directing the resumption of work,) resulting in the acceptance of the work.

The two localities designated above the canal were found to be projecting points of the same shoal, and of much larger extent than that supposed. The work at these points was inspected and accepted; the first on the 9th and the last on the 27th of November, and the contract, therefore, completed and closed, and the balance due thereon paid to the contractors.

The amount of dredging required greatly exceeded all the estimates. The contractors performed more than double the work anticipated, and yet the entire navigation was but little improved; though what was accomplished was directly toward that end. This was due to the fact that the obstructions did not consist of detached boulders, as originally represented, and upon which a previous report and estimate were predicated, but of extensive shoals composed of boulders.

In accordance with instructions from the Chief of Engineers, a project was submitted to him on the 1st of September, 1870, with a view to the construction of new lockage alongside that existing, and the excavation of the prism of the canal to a certain indicated width and depth. This was approved in general, but subsequently modified specifications, with a report on the subject, were also submitted for approval, for so much of the new work as might be accomplished under the appropriation available, involving the enlargement of the prism, as well as the construction of a revetment wall and guard-gates. This modified project was also approved, and after due advertisement a contract was entered into, October 20, 1870, with Messrs. Barker, Williams, and Bangs, the lowest bidders, for the prosecution of the work. The contract providing for the enlargement of the prism of the canal by excavation of the sides and bottom, so that when the revetting walls should be built the dimensions of the water-way above the new position of the guard-gates would be as follows:

	Feet.	Inches.
Width at coping of revetting walls	102	6
Width at surface of water, 5 feet below coping	100	0
Width at 13 feet in depth	93	6
Width at 20 feet in depth	73	6
Depth of bottom along axis of canal, and for 36 feet 9 inches on each side thereof, measured from level of coping.	20	0
Depth at 46 feet 9 inches on each side of the axis, measured from level of coping	18	0
Slope of sides after wall is built, or of excavation, where it is in rock for 18 feet in depth below coping, 3 inches to 1 foot.		
Slope of sides from above-named limit to bottom of canal, 60 inches to 1 foot.		

The contract also embraced the construction of a revetment wall, and new guard-gates, the latter upon the plan of the old ones and to be placed in position at least 700 feet nearer the head of the canal.

The contract further provided that the contractors should receive as full compensation for the work performed, upon approximate monthly estimates, the following rates, viz:

For rock excavation	$3 50 per cubic yard.
For gravel excavation	80 cents per cubic yard.
For revetting wall	15 cents per cubic foot.
For rebuilding guard-gates, $15,000.	

All measurements to be made in situ, and the work to be commenced on or before the 20th of October, 1870, and completed on or before the 1st day of July, 1871.

The plan of operations for the winter involved the removal of the guard-gate to the new position; the deepening of the water-way, the removal of the side slopes, and the revetment of the sides of the cut with a wall of stone; the work to be commenced at the upper entrance to the canal and continued downward until the appropriation should be exhausted.

For nearly the whole distance from the inner end of the south pier to the guard-gates the rock appears above the water's surface, and from the inner end of the south pier westward appears to have a slope to the westward of about 1 to 60. The rock is Potsdam sandstone, red and gray in alternating strata, and of very variable hardness, some so soft as to be removed easily with a pick and shovel.

The revetting wall was to be founded on the first stratum of suitable rock found in the sides of the excavation. Below the base of the wall the face of the rock was to be dressed off to leave a smooth and uniform surface.

Contrary to expectation it was discovered that the excavation would furnish but little, if any, stone fit for use in constructing a revetting wall. It was believed that a sufficient quantity would be thus obtained to at least bring the walls to the surface of the water, and owing to the lateness of the season nothing else could have been relied upon. Stone could not have been quarried at Sandusky or elsewhere and carried to the canal before the close of navigation. Under these circumstances it was necessary to modify the previously adopted plan of operations by postponing the removal of the guard-gates and the construction of the revetment until another season, and substitute for all of the revetment under water, timber in the ordinary form of cribs instead of stone as specified in the contract, provided the contractors were willing to put it in place complete at a price no greater in aggregate than a stone wall of the same height would amount to at the contract price. This plan being approved and the contractors assenting thereto, the specifications were modified accordingly.

The work of excavation was begun the latter part of October, the dredge operating on a shoal projecting into the channel past the outer end of the south pier. A force of laborers were employed removing the old slope wall from the tow-path to the water's surface, commencing at the inner ends of the piers at the head of the canal, working eastward and ending at a point 600 feet above the guard-gates.

A dam was thrown across the canal at the inner end of the south pier, but it was impossible to make it perfectly water-tight. A very considerable amount of water passed around the north end of the dam through a thin stratum of earth lying between strata of rock about 7 feet below the water-line. Moreover this dam happened to be placed over one of the places shattered some distance below the requisite depth by blasting when the canal was built, and water found a passage through the crevices thus made in the rock beneath.

Much difficulty was experienced in controlling the leakage, and on this account some delay attended the progress of the work. After the failure of repeated attempts on the part of the contractors to overcome this trouble, sufficient machinery for pumping was procured (some of it carried overland from Detroit) and placed in operation with slow but ultimately successful results. It consisted of a 12-inch Holly wrecking pump, two 6-inch lift pumps, one 4-inch lift and force pump, and three centrifugal pumps; one with a 5-inch, one with a 6-inch, and one with a 10-inch discharge pipe. Of these, two of the centrifugal pumps proved the most efficient.

During December and a portion of January, however, when arrangements were being made and carried into effect for overcoming the leakage, the workmen were employed in removing the slopes from the water-line nearly to the bottom of the canal; in the meantime the water leaking through the dam and running down the canal rapidly froze and soon covered the bottom with two feet of ice.

By the 8th of January the slopes had been removed to a point to which it was estimated the appropriation would cover the cost of the completed work.

Excavation above the dam was done by dredging. For 300 feet from the outer end of the south pier inward, the dredge completed the excavation, removing the rock with some difficulty, but east of this area the rock was generally too hard and the strata too heavy.

An attempt was made in the early part of the winter by the contractors to loosen the rock for dredging by using a heavy chisel weighing 4,000 pounds, fitted in leaders like the hammer of a pile-driver, but this proved unsuccessful.

The excavation below the canal was suspended on the 6th of May, and the removal of the dam commenced. Before the evening of the 8th an opening had been made sufficient to permit the passage of vessels.

After the opening of navigation the dredge was employed in completing the removal of the shoal beyond the outer end of the south pier, and in cleaning up some small ridges of loose material over the area dredged between the piers.

The entire amount of excavation to June 30, 1871, was, of rock, 30,383.17 cubic yards; of gravel, 4,307.19 cubic yards.

During the fall and winter I caused a minute survey of the site of the canal and vicinity to be made and a map of the same transmitted to me by Mr. Alfred Noble, the assistant in immediate charge of the improvement.

A daily record of the height of the water surface above and below the locks has been kept by my direction, and reported to me at the close of every month, in tabular form. A diagram indicating the results obtained in this manner has been prepared, a tracing of which accompanies this report.

A table has also been prepared showing the mean elevation of the surface of the water above and below the locks above the datum plane of the survey of the canal, referred to (103.50 feet below the miter-sill of the guard-gates) for each month, from November, 1870, to June, 1871, inclusive, and the mean elevation in each month during the prevalence of winds from each quarter of the compass. This table is also transmitted herewith.

It becoming evident that the first appropriation was not sufficient to keep the work going energeticlly all winter, an additional appropriation of $100,000 was asked for, and made by Congress February 2, 1871. A plan for the expenditure of the same, if granted, had been submitted to the Chief of Engineers, January 28, 1871. It consisted of a proposition to continue the work of improving the prism, following the plan already approved, and to employ the same contractors at the rates named in their contract. This proposition was approved February 3, 1871, with the understanding that a new contract be entered into; and accordingly an agreement was made with Messrs. Barker & Williams, two of the contractors, for continuing the work at the same prices under the temporary appropriation referred to, Mr. Bangs withdrawing from the firm. The 1st of May, 1872, was fixed as the limit of the new contract.

By act of Congress, approved March 3, 1871, the further sum of $250,000 was appropriated for the improvement of the canal and river. It being deemed the most desirable to expend this amount in the construction of the new locks, plans and specifications were at once commenced, both for a system of two locks, each 80 feet by 400 feet, and a single lock to overcome the difference of level at one lift, the horizontal dimensions to be 80 feet by 400 feet. The work of preparing these plans has progressed ever since, but in view of the great amount of money involved in the work which they are to illustrate, much more time and careful study have been devoted to their preparation than would have been under ordinary circumstances. I feel that the magnitude and importance of the work demand this care and deliberation; hence the plans are yet in an unfinished state.

Authority was granted by the Chief of Engineers, April 22, 1871, to extend the contract with Messrs. Barker, Williams & Bangs, which expired July 1, 1871, to July 1, 1872. This extension was made because certain portions of the work could not be done before another winter, owing to the utter impossibility of procuring the requisite materials, due to no fault upon the part of the contractors, who, as well as the agents of the United States, expected to obtain the materials from the excavation of the canal itself, but were disappointed. The deferred work, except obtaining and preparing the materials, can only be done when the water is out of the canal, and is therefore necessarily thrown into another season.

The work thrown over is the revetment of the sides of the canal, and the removal and rebuilding of the guard-gates. The latter could easily have been removed from their present position, but could not have been rebuilt. I therefore directed that they should not be disturbed, since the safety of the locks and indeed the entire canal would surely have been imperilled thereby.

The approved plan for the enlargement of the prism and a new system of lockage requires land additional to the original grant, as well as the purchase of several lots at the lower end, now belonging to individuals. The latter are required to effect an entrance into the new locks, and must be acquired before any work upon them is done, since the excavation, to be carried on with the greatest economy, must be begun at the extreme lower end, and be carried thence into the lock pit.

Accordingly I wrote his excellency the governor of Michigan the following letter:

DETROIT, MICHIGAN, *January* 27, 1871.

SIR: I respectfully invite the attention of your excellency to the necessity of taking steps to secure right of way for the improvement of the St. Mary's Falls Canal, now in progress.

Yesterday an additional appropriation of $100,000 passed the United States Senate, available for immediate expenditure. Should the House, as it doubtless will, at once pass the same bill, and Congress follow this with an appropriation of $500,000 available after the 1st of July next, the work can be pushed with great energy. But nothing can be done beyond the limits of the present grant without first acquiring the right of way, or rather the ownership in fee of the land required. This is absolutely essential, and unless steps are taken at once, I greatly fear delay from this source.

The legislature of Michigan, now in session, could readily pass any law that may be required. It is possible that the laws of Michigan, now in force, provide for such cases. When the United States purpose spending over a million of dollars upon this improvement, so important to the interests of Michigan, surely there can be no hesitation concerning any legislation which may be necessary to give full effect to the intention of the General Government.

In case any legislation is necessary I might refer to the present laws of the State, providing for the condemnation of private property for light-house purposes, and cession of jurisdiction over such property, as affording a convenient basis upon which to frame laws to cover this special case.

I am, sir, with great respect, your obedient servant,

O. M. POE,
Major of Engineers.

His Excellency H. P. BALDWIN,
Governor of Michigan, President Board of Control.

To this communication the governor replied as follows:

STATE OF MICHIGAN,
Executive Office, Lansing, February 2, 1871.

DEAR SIR: I am in receipt of yours of January 27, relative to the right of way for Sault Ste. Marie's Canal.

The State holds 400 feet of land for the whole length of the canal. Will your improvement cover more than this width? If not I presume no action will be required. Please advise.

Very respectfully, yours,

H. P. BALDWIN.

General O. M. POE, *Detroit.*

An act drawn by the attorney general of the State was passed by the legislature, and duly approved by the governor. But this act only provides for the seizure of the required lands by the State of Michigan, and makes no provision for their transfer to the United States.

Desiring to expedite the aquisition of the additional lands, I wrote the following letter:

DETROIT, MICHIGAN, *May* 12, 1871.

SIR: I have very respectfully to inqnire what steps, if any, are being taken to acquire title to the additional land needed in the enlargement of the Saint Mary's Falls Canal. Also, whether it is the intention of the board of control to proceed further in the matter; and if not, the present status of the negotiations, to the end that the United States may act.

Very respectfully,

O. M. POE,
Major of Engineers and Brevet Brigadier General, U. S. A.

His Excellency H. P. BALDWIN,
Governor of Michigan and President Board of Control, Detroit.

And the next day received the following reply, from which it is seen that action is postponed until after the 30th of June, the date upon which this report closes. The subsequent action of this matter will be made the subject of a special report:

STATE OF MICHIGAN,
Executive Office, Detroit, May 13, 1871.

DEAR SIR: In reply to yours of May 12, I have to state, that the legislature at its recent session passed an act authorizing the governor to appoint a commission of three persons to condemn such lands as may be needed for the enlargement of the St. Mary's Falls Ship Canal; before this can be done it will be necessary that I receive official notice that lands are required for that purpose, accompanied with a plat and description of the lands wanted. On receiving such notice and plat, action will be taken.

I am expecting to be absent for a few weeks, and early in July to visit the canal, at which time the commission can be appointed if so desired.

Very respectfully,

H. P. BALDWIN.

General O. M. POE, *Detroit.*

Under date of the 16th of June I called the attention of the contractors to the fact that no sufficient examinations had been made for the purpose of determining the extent and character of the coffer-dams, which they propose to use for next winter's work, and that it would probably be necessary to cut a channel, at least on the back of the north pier, to be filled with water-tight material, in which case the work should be taken in hand at once, and that the clay and other material required for this dam should also be obtained, and put upon the ground at as early a day as practicable, to the end that no delay might take place in getting the dam in; that in fact a considerable portion of the dam might be put in before the close of navigation.

Their attention was also invited at the same time to the necessity for having upon the spot, where needed, the timber required for rebuilding the revetment.

Acting upon these suggestions, the work of delivering the stone and timber was taken in hand without delay and is now in progress. Operations during July and August have consisted entirely in the delivery of this material.

The following shows the present financial condition of the improvement:

Amount available July 1, 1870, $ ——— .

AMOUNTS UNDER CONTRACT.

Amount appropriated July 11, 1870	$150,000 00
Amount appropriated February 2, 1871	100,000 00
Total	250,000 00
Amount expended from July 1, 1870, to July 1, 1871	108,318 41
Balance (all of which is under contract)	141,681 59

Amount appropriated March 3, 1871, but not yet under contract	$250,000 00
Amount available July 1, 1871	391,681 59
Amount required for the fiscal year ending June 30, 1873	884,977 08

The balance of $141,681 59, on hand at the beginning of the present fiscal year, includes $10,978 67, being aggregate amount of percentage retained from payment made to contractors from time to time in accordance with the terms of their contract, and the materials already delivered (timber for revetment and stone for guard-gate walls) cover some portion of this balance, but are not to be paid for until placed in the work.

No attempt is made to give statistics concerning the importance of this work, as it is so well known. Suffice it to say that nothing can pass, by water, between Lake Superior and the lower lakes without passing through this canal. The commerce interested is the entire traffic by vessels between Lake Superior and the other lakes, and large as it now is, will, as the Northern Pacific and other railroads having a terminus upon Lake Superior are extended, rapidly and greatly increase.

In naming an amount to be appropriated at the next session of Congress, I am guided by the estimated cost of the new system of lockage, which is $884,977 08. It is of importance that this entire amount should be appropriated in one item, in order to put the work under one contract. To appropriate it by piecemeal may throw the work into the hands of different contractors, thus securing the most work at the maximum of cost. The appropriation of the whole amount at one time will greatly reduce all incidental expenses and reduce the time before completion to a minimum.

I feel as though I could not press this matter too earnestly; and I farther desire to say that I have, in the estimate, left no margin for reduction; even if only $50,000 be taken off, I doubt whether enough would be left to accomplish the object.

All of which is respectfully submitted.

O. M. POE,

Major of Engineers and Brevet Brigadier General, U. S. A.

Table showing the mean elevation of the surface of the water in the St. Mary's Falls Ship Canal, above the datum plane, during each month from November 1870, to June, 1871, and the mean elevation for each month from December, 1870, to June, 1871, during the prevalence of winds from different quarters.

Month.	Mean elevation of water's surface above datum plane.		Mean elevation of water's surface above the datum plane during prevalence of winds from west to north, including west and excluding north winds.						Mean elevation of water's surface above the datum plane during prevalence of winds from north to east, including north and excluding east winds.						Mean elevation of water's surface above the datum plane during prevalence of winds from east to south, including east and excluding south winds.						Mean elevation of water's surface above the datum plane during prevalence of winds from south to west, including south and excluding west winds.					
	Above locks.	Below locks.	Above locks.			Below locks.			Above locks.			Below locks.			Above locks.			Below locks.			Above locks.			Below locks.		
	Height.	Height.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.	No. of observations.	Height.	Variation from mean for entire month.
1870.																										
November *	115.95	98.16	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......
December	115.73	97.98	10	115.89	+0.16	10	98.14	+0.16	0	......	......	1	97.79	−0.19	7	115.51	−0.22	8	97.67	−0.31	10	115.70	−0.03	11	98.08	+0.10
1871.																										
January	115.29	98.39	6	115.67	+0.38	7	98.74	+0.35	4	115.28	+0.01	3	98.25	−0.14	14	115.16	−0.13	13	98.29	−0.10	6	115.26	−0.03	6	98.27	−0.12
February	115.14	98.40	12	115.23	+0.09	12	98.54	+0.14	0	......	......	0	......	......	14	115.05	−0.09	16	98.27	−0.13	0	......	......	0	......	......
March	114.87	98.33	12	114.97	+0.10	12	98.36	+0.03	1	114.88	+0.01	1	98.18	−0.15	11	114.65	−0.22	11	98.20	−0.13	6	115.06	+0.19	7	98.50	+0.17
April	115.60	97.94	10	115.13	+0.13	11	97.95	+0.01	2	115.33	+0.33	2	97.88	−0.06	12	114.81	−0.19	13	97.94	0.00	4	115.07	+0.07	4	97.94	0.00
May	115.58	98.36	17	115.75	+0.17	17	98.36	+0.00	4	115.25	0.33	4	98.23	−0.13	7	115.35	−0.23	7	98.46	+0.10	3	115.59	+0.01	3	98.31	−0.05
June	115.99	98.58	20	116.08	+0.09	20	98.57	+0.01	0	......	......	0	......	......	4	115.87	−0.12	4	98.64	+0.06	6	115.75	−0.24	6	98.57	+0.01
Mean from December to June, inclusive	115.37	98.28	...	115.53	+0.16	...	98.38	+0.10	...	115.69	†0.00	...	98.07	‡−0.13	...	115.20	−0.17	...	98.21	−0.07	...	115.40	§−0.01	...	98.28	§−0.02
Mean from November to June, inclusive	115.44	98.27	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......	...	......	......

* The record of the direction of the wind was commenced November 22, 1870.

† Variation from the mean of January, March, April, and May.

‡ Variation from the mean of December, January, March, April, and May.

§ Variation from the mean of December, January, March, April, May, and June.

CUSTOM HOUSE, MARQUETTE, MICHIGAN,
Collector's Office, October 10, 1871.

SIR: In reply to your communication of June 15th, I have the honor to report:

1st. That the total amount of revenue collected in the district of Superior for the fiscal year ending June 30, 1871, was $8,467 43.

2d. The amount of revenue collected at the port of Sault Ste. Marie during the same time was about $3,000.

3d. In reply to your further inquiry as to the amount of commerce and navigation which will be benefited by the proposed improvement of the St. Mary's Canal and River, I respectfully submit herewith two statistical tables as answering your inquiry in two ways: 1st. By exhibiting in Table A the actual tonnage employed in the commerce which passed through the canal for a series of years; 2d. By exhibiting in Table B the two particular interests which, up to the present time, have formed the basis for nearly all the commerce of Lake Superior that passes through the canal, the magnitude of which is shown in Exhibit A.

A reference to Exhibit A will show that the growth of the commerce passing through the canal has been not only *rapid* but *constant*. Each year shows a large gain over the previous year. In view of the activity in railroad construction now characterizing lines terminating at the head of Lake Superior, affording to the already settled portions of the Northwest a new and cheaper outlet for its surplus products and opening new territory of the most attractive character, it is fair to presume that the annual increase of the tonnage passing through the canal will for some years, at least, be maintained if not greatly augmented.

Table B also exhibits a marvelous development of the mining industries of Northern Michigan; and in considering this exhibit one should bear in mind a few facts which are not apparent on its face, and to the general observer may be unknown, as, for instance: During the year 1870, nearly one-third of all the iron and three-fourths of all the copper produced in the whole United States was taken from the mines of Lake Superior, the principal commercial outlet for which, is through the canal.

There are more than two hundred blast-furnaces, rolling-mills, and other iron works located in the States of Michigan, Wisconsin, Illinois, Indiana, Ohio, Pennsylvania, and New York, which are dependent, in whole or in part, upon the mines of Lake Superior for their supply of ore. The area of country over which this ore is carried is almost continental in extent, embracing not only all the great bituminous coal fields of the West, but also the anthracite region of the East.

In my opinion a half a million dollars would have been saved to the consumer of iron during the year 1870 upon the single item of lake transportations on *iron ore*, had the canal permitted the passage, full loaded, of the largest class of vessels navigating the lower lakes.

The report of the superintendent of the canal for four and a half months, two-thirds of the present season, shows an increase of tonnage over same time of 1870 of about 25 per cent., nearly all of which is to be attributed to the new trade brought to the head of the lake by the Lake Superior and Mississippi Railroad and the Northern Pacific. In view of present *facts*, speculation as to the future trade which is to be poured into Lake Superior by this highway for the world is uncalled for.

That the time has passed when the St. Mary's Falls Canal, as originally constructed, can serve the wants of commerce, is painfully felt by those engaged in navigation.

An emergency already exists, and the proposed improvements should be hastened forward to completion at the earliest moment practicable.

Very respectfully, yours,

HIRAM A. BURT,
Collector

General O. M. POE,
Detroit, Michigan.

Exhibit A.

Statement of the number of vessels, and their tonnage, passing through the St. Mary's Falls Ship Canal each year from 1865 *to* 1870, *inclusive, and four and a half months of* 1871.

Year.	No. passages.	Tonnage.
1865	997	409,062
1866	1,008	458,530
1867	1,305	536,898
1868 *	1,115	432,463
1869	1,336	526,323
1870 †	1,883	696,855
1871, ½ of June	1,311	576,773

* In June, of this year, three out of the four shipping docks at Marquette were destroyed by fire cutting off the facilities for shipping ore, and damaging seriously the business of that year.

† The increase over the year previous is about 33⅓ per cent.

Exhibit B.

Statement of the product of the iron and copper mines of Lake Superior for each year during a period of ten years, from 1861 *to* 1870, *inclusive.*

Year.	IRON.			COPPER.	
	Iron ore.	Pig iron.	Value.	Ingot copper.	Value.
	Gross tons.	*Gross tons.*		*Tons.*	
1861	45,430	7,970	$419,401	7,500	$3,337,500
1862	115,721	8,590	98[illegible],977	6,300	3,402,000
1863	185,257	9,813	1,416,935	6,500	4,420,000
1864	235,123	13,832	1,867,215	6,500	6,110,000
1865	*196,256	12,283	1,590,430	7,000	5,145,000
1866	296,972	18,436	2,405,960	7,000	4,760,000
1867	466,076	30,911	3,475,820	8,200	4,440,000
1868	507,813	38,246	3,992,413	9,985	4,592,000
1869	643,230	40,000	5,296,318	12,200	5,368,000
1870	856,471	50,000	6,256,769	12,381	5,557,600

* Year of the close of the war.

The average annual rate of increase of the iron business for ten years is 45 per cent. The rate of increase for 1870 over 1869 is 33⅓ per cent.

Estimated product of 1871 1,000,000 tons.

Table showing the aggregate tonnage of vessels and steamers passing St. Mary's Falls Canal for each month from May to September, in 1870 *and* 1871.

Month.	Tonnage 1870.	Tonnage 1871.
May	113,241.5	77,735.78
June	116,566.5	123,565.49
July	121,362.5	154,923.85
August	106,662.3	115,056.93
September	96,529.0	103,490.40
Total	534,361.8	574,772.45

The increase for 1871 is 20,410.65 tons. There is, however, a decrease in the number of vessels, the number locked through in 1870, up to October 12, being 1580, against 1366 for the present year. This comparison shows that the vessels now passing are of a larger class than those heretofore in use for this trade.

UNITED STATES ENGINEER OFFICE,
Detroit, Michigan, August 25, 1871.

GENERAL: By act of Congress approved March 3, 1871, the sum of $10,000 was appropriated "For improvement of Cheboygan Harbor, Michigan," and on the 14th of March the work was assigned to my charge.

At this early date lake navigation had not opened, and nothing more was then done than to ask for maps and reports previously made by other officers, and to write to certain citizens of Cheboygan for the purpose of getting some expression of opinion as to the best manner of expending a sum so utterly inadequate to the making of any valuable improvement.

After due consideration I submitted the following project.

DETROIT, MICHIGAN, *April* 10, 1871.

SIR: The appropriation of $10,000 made by act of Congress, approved March, 3, 1871, "For improvement of Cheboygan Harbor, Michigan," being utterly inadequate to make the improvements suggested in the report of Captain F. U. Farquhar, corps of engineers, dated December, 1870, and which I approved, I propose that it be expended toward that project by dredging within the limits prescribed by Captain Farquhar for the east and west piers as follows:

"Make the west line of the cutting parallel with the west line of the west pier, and twenty-one feet from it."

"Make the width of the cutting at top, in shoalest water 100 feet wide."

"Make the depth 9 feet at stage of survey of August, 1870."

"Make the bottom of the cut 50 feet wide throughout, sloping the sides to conform to these dimensions.

"Begin the dredging in 9 feet water and work inward."

And I submit herewith the form of an advertisement, inviting proposals for the work, which if approved, I have to request may be forwarded to the chief clerk of the War Department for appropriate action.

I propose to fill up this form so as to give full thirty days' notice of the time at which bids will be opened.

Very respectfully, your obedient servant,
O. M. POE, *Major of Engineers.*

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

This project was approved by the Chief of Engineers on the 14th of April, and proposals for the work were invited, the bids to be opened on the 24th of May.

The following is an abstract of the bids opened on that day together with correspondence relating thereto.

DETROIT, MICHIGAN, *May* 26, 1871.

GENERAL: I have the honor to transmit herewith an abstract of proposals for dredging at the harbor of Cheboygan, Michigan, opened at 3 o'clock p. m. on Wednesday, the 24th instant, in accordance with advertisement dated April 20, 1871.

I also inclose a copy of correspondence with Mr. Charles Fitzsimons, relating to his proposal, which did not specify whether the price named by him was for material measured in scows or in bank. You will perceive that he leaves it discretionary with me to determine the manner in which the material shall be measured; and I have accordingly entered his bid in the abstract as being per cubic yard measured in bank. His proposal being the lowest, I therefore respectfully recommend its acceptance, and that I be authorized to enter into a contract with him for the execution of the work.

Very respectfully,
O. M. POE,
Major of Engineers and Brevet Brigadier General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Abstract of proposals for dredging at the harbor of Cheboygan, Michigan, opened at 3 *o'clock p. m., Wednesday, the 24th day of May,* 1871, *in accordance with advertisement, copy herewith.*

Bidders' names.	Price per cubic yard in bank.	Price per cubic yard in scows.	Work will be begun.	Work will be finished.	Guaranty.
	Cents.	*Cents.*			
C. Fitzsimons, Chicago, Ill	30	....	June 15	October 30	Yes.
James Roberts, Chicago, Ill	40	29	June 24	October 24	Yes.
Caskin & Stickney, East Saginaw, Mich	42	28	June 20	November 1	Yes.
E. T. Williams & Co., Sault Ste. Marie, Mich	45	34	June 10	September 10	Yes.
Thomas M. Hubbell, East Saginaw, Mich	40	30	June 25	December 1	Yes.
Alanson Dodge, Fulton, N. Y	50	38	June 20	November 1	Yes.

O. M. POE,
Major of Engineers and Brevet Brigadier General, U. S. A.
DETROIT, MICHIGAN, *May* 26, 1871.

DETROIT, MICHIGAN, *May* 24, 1871.

SIR: Your bid for dredging at Cheboygan, Michigan, fails to state whether the material is to be measured in the bank or in scows. Please inform me at once. I will wait until the morning of the 27th instant for your reply.

All the other bidders have named a price for the dredging measured in the bank, and another price—the measurement to be made in scows.

Very respectfully,

O. M. POE,
Major of Engineers and Brigadier General, U. S. A.

Mr. CHARLES FITZSIMONS,
37 Union Building, corner La Salle and Washington Street, Chigago, Illinois.

CHICAGO, *May* 25, 1871.

GENERAL: Your letter of the 24th ultimo, relating to dredging Cheboygan Harbor, is this moment received.

In reply I would state that my bid was 30 cents per cubic yard, expecting the measurements to be made by the engineer officer in charge in any manner he pleased.

I am, general, very respectfully, your obedient servant,

CHARLES FITZSIMONS.

Major O. M. POE,
U. S. Engineers, and Brevet Brigadier General, U. S. A., Detroit, Michigan.

Under date of the 31st of May, 1871, the Chief of Engineers authorized me to accept the bid of Mr. Charles Fitzsimons, whereupon I notified him of the fact.

DETROIT, MICHIGAN, *June* 8, 1871.

GENERAL: A Mr. Kimball, representing himself as an agent of Charles Fitzsimons, of Chicago, (whose bid for the work at Cheboygan has been accepted,) having in his possession the contracts for the dredging at Cheboygan, called upon me a few minutes ago, and after exhibiting the contracts, began to make inquiries concerning the character of the material to be removed, and expressed a desire to have the specifications modified so as to classify the material; with a view, as I understand it, to obtain different prices for different kinds of material, though neither my advertisement nor Mr. Fitzsimons's bid contemplated anything of the kind. I once declined to hold any conversation upon the subject with any but the principal, Mr. Fitzsimons.

Inasmuch as Mr. Kimball failed to leave the contracts (which I have reason to believe were duly signed and executed) with me, but carried them away with him, I infer that it is the intention of Mr. Fitzsimons to decline the award. This is without excuse, as I stood ready at any and all times, previous to the opening of the bids, to give to all applicants whatever information was in my power, and all the bidders, except Mr. Fitzsimons, did make inquiry concerning the work to be done. I had doubts as to the character of his bid at the time it was opened, but considered that I had no right to act upon them. Before recommending its acceptance, however, I wrote to him for an interpretation of his bid, and transmitted to the Chief of Engineers a copy of the correspondence with the abstract of bids. The bid of Fitzsimons was much more advantageous to the United States than any other, and I therefore recommended its acceptance.

If Mr. Fitzsimons fails now to enter into contract, it will cause delay and serious inconvenience. I report the foregoing facts at this time with a view to an application for authority to proceed against Mr. Fitzsimons, in case he does not complete the contracts within the specified fifteen days from the date upon which he was notified that his bid was accepted.

Since Mr. Kimball's interview with me I have written to Mr. Fitzsimons, and inclosed, herewith, a copy of my communication.

Very respectfully, your obedient servant,

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

GENERAL: In addition to abstract of bids for dredging at Cheboygan Harbor, Michigan, and copy of explanatory correspondence with Mr. Charles Fitzsimons, of Chicago, transmitted with my letters of the 26th ultimo and 8th June, I have the honor to now inclose a copy of further correspondence with Mr. Fitzsimons.

As the fifteen days within which he was to enter into contract for the due performance of the work have elapsed, without hearing from him in reply to my letter of the 12th instant, I assume that he adheres to the tenor of his letter of the 9th instant, and declines the contract.

I am satisfied that nothing will be gained by again advertising for proposals, but, on the contrary, much valuable time will be lost, and therefore respectfully recommend that I be authorized to accept the next lowest bid, namely, that of Messrs. Caskin & Stickney, at 28 cents per cubic yard, the dredged material to be measured in the scows; and, to save time, request that this authority be communicated to me by telegraph.

Very respectfully,

O. M. POE,
Major of Engineers, and Brevet Brigadier General U. S. A.

DETROIT, MICHIGAN, *June* 27, 1871.

SIR: In accordance with instructions from the Chief of Engineers, I hereby notify you that I will proceed to put the work of dredging at Cheboygan, Michigan, under contract upon the best terms I can, and will hold you and your guarantors responsible for the difference between your bid and the price at which I am able to get the work done, together with any expenses arising therefrom, in addition to what would have been incurred in case you had conformed to the terms of your bid.

Very respectfully,

O. M. POE,
Major of Engineers, and Brevet Brigadier General U. S. A.

Mr. CHARLES FITZSIMONS,
37 *Union Buildings, Chicago, Ills.*

The contract was then awarded to Messrs. Caskin & Stickney, deemed the next lowest bidders, at 28 cents per cubic yard, measured in the dumping-scows, and they were accordingly notified to enter into contract.

The sum appropriated will probably be all expended before the close of the present season, but the resulting improvement will fall far short of what is required. For the next fiscal year I respectfully recommend an appropriation of $50,000, which I trust will be sufficient to do all the dredging immediately necessary.

Cheboygan is in the collection district of Michigan.

The nearest light-house is Cheboygan, distant two miles.

During the fiscal year ending June 30, 1871, 195 vessels, representing a tonnage of 32,131 tons, and carrying 1,222 men, entered at Cheboygan, and 300 vessels, representing a tonnage of 55,517 tons and 2,545 men, cleared from the same port.

The amount heretofore appropriated for this improvement is $10,000.

All of which is respectfully submitted.

O. M. POE,
Major of Engineers, and Brevet Brigadier General U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

C 3.

REPORT ON THE IMPROVEMENT OF AU SABLE RIVER, MICHIGAN.

The first work done last season consisted of repairing and replacing the 18-feet wide crib at the outer end of the north pier. This was done by leveling the stone left on the bottom when the crib, originally placed there by the contractors, but not accepted, was carried away during a gale which occurred in the previous autumn, and then sinking the crib and settling it on the bottom thus formed.

The stone taken up while bringing this bottom to a level were used as riprap at end of south pier until the crib was sunk, when they were put into it. The gap, G H, (see diagram No. 1 of this report,) was filled by placing and ballasting nine cribs, each 16 feet in width.

The north pier was also leveled up and the superstructure on it finished, the height above mean low water being 5 feet. Except the outer crib this work has stood excellently well. This outer crib has settled toward the harbor on inner corner $\frac{19}{100}$ of a foot, on the outer corner $1\frac{79}{100}$ feet, and on the outer corner of the back of the crib $\frac{45}{100}$ of a foot, and in settling has wrenched apart the end timbers where it connects with the other work, tearing the joists out of the jams. This will have to be repaired.

During the present season four of the nine cribs in gap G H, and six between F and G, have settled on the harbor-face to the extent of 12 to 18 inches, caused by the scouring action of the current, which here runs very swiftly. To overcome this tendency to settling may ultimately require riprapping. The effect of this scouring action has been to increase the depth of the water along the harbor-face of the south pier from 11 to 11½ feet at the beginning of May, to 12 and 12½ feet at the close of June. All work previously riprapped has stood well.

Many rafts are brought out of the river, and frequent damage to the piers arises from this source. But little injury would be caused if the piers were straight; owing to the angle in them, and the very rapid current, these heavy rafts usually swing against the south pier. Several timbers have been torn off by these rafts catching on the pier, as well as by drift-logs pounding upon it. When the superstructure is built upon it, much of this difficulty will be obviated.

Comparing the depth of water in the channel with that of previous years, the harbor shows a marked improvement. Closing the gap G H has increased the current so much that it has entirely removed the bar in front of the harbor mouth, and made a channel of 10½ to 11 feet in depth. The river inside shows an average depth of 11½ feet.

The vessels used at this port are increasing in size and number every season. Three new mills have been projected, and probably will be built within a year. (One very fine mill is now ready, but for want of logs is not yet started.) Two of these mills will ship entirely from the river; the other will ship from a dock on the lake-shore; but in rough weather docks on the lake-shore cannot be approached, and the river must be used as a harbor by all of them.

The recommendation of last year, to extend the piers, as indicated in red on the accompanying diagram, is renewed.

By act of Congress approved March 3, 1871, the sum of $10,000 was appropriated for this improvement. It was deemed best to expend this toward the superstructure of the south pier, and by advertisement dated May 19, proposals for materials and labor to the extent of the appropriation were invited. These were opened on the 22d of June, and Wm. H. Patten being the lowest bidder for the work as a whole, it was recommended that it be awarded him, and by authority of the Chief of Engineers, contracts have been entered into accordingly.

Au Sable is situated between the light-houses at Sturgeon Point and Tarvas, and is about fourteen miles from the latter. It is in the collection district of Huron, Michigan.

The appropriations heretofore made for this improvement are as follows:

By act of 2d March, 1867	$50,000 00
By allotment act of 1869	2,970 00
By act of 11th of July, 1870	15,000 00
By act of 3d of March, 1871	10,000 00
	77,970 00
Of which there has been expended the sum of	67,969 36
	10,000 64
And the available amount from the act of March 3, 1871, now under contract, &c	10,000 00
Balance	10,000 64
The amount estimated to complete the improvement (see page 154, Annual Report Chief of Engineers, 1870) was	$43,765 14
From which should be deducted appropriation now available	10,000 00
Balance	33,765 14

Ordinarily this balance would represent the amount yet to be appropriated to complete the work, but, as is well known, the aggregate is increased by making appropriations in installments, and I therefore deem it best to recommend that the sum of $35,000 be appropriated to continue the work. If the entire amount is appropriated at one time, I think it will finish the improvement.

The following statistics of the commerce of the place are only approximate, but are thought to be reliable:

During the fiscal year ending June 30, 1871, 160 steamers and 300 sail-vessels, capable of carrying from 150,000 to 300,000 feet of lumber, entered and departed from this port; 75,000,000 feet pine lumber were manufactured and shipped from this port; also, 8,000 barrels fish. The lumber-manufacturing establishments were not run to their full capacity.

All of which is respectfully submitted.

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

C 4.

REPORT OF OPERATIONS FOR THE IMPROVEMENT OF THE SAGINAW RIVER.

By act of Congress approved July 11, 1870, the sum of $1,500 was appropriated for this work. The estimate upon which this appropriation was based was made to meet a contingency which might possibly arise. No complaint concerning this improvement has reached me, and it doubtless continues to prove efficient and valuable; though it is proposed to expend the appropriation now available in making a survey to determine the present condition of the channel with a view to future recommendations. No estimate is submitted, because it is not thought that any appropriation will be required.

Respectfully submitted.

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

C 5.

UNITED STATES ENGINEER OFFICE,
Detroit, Michigan, July 21, 1871.

GENERAL: By letter of instructions from the Chief of Engineers, dated March 21, 1871, I was directed to make a survey and estimate for removing middle ground at the mouth of Black River, in St. Clair River, Michigan. I immediately organized a surveying party, under charge of Colonel H. A. Ulffers, assisted by Mr. Roys J. Cram, which reached the locality on the morning of the 30th March, and at once commenced the work. The report of Colonel Ulffers is as follows:

PORT HOPE, MICHIGAN, *July* 11, 1871.

MAJOR: In compliance with instructions dated March 29, 1871, I have the honor to report that I proceeded, on the morning of March 30, in company with Mr. Roys J. Cram, to Port Huron, Michigan, for the purpose of making "a survey and estimate for removing the middle ground at the mouth of Black River, in St. Clair River, Michigan."

After making the necessary preparations and purchases we commenced the survey of the shore lines on April 1. The natural condition of the shore, as well as the crowded state of the wharves and docks, compelled us to run our base lines in the heart of the city on Huron avenue and Military street. Stations along shore for observing lines of sounding were put up and carefully connected with the base lines. On April 6 the surveys were completed and soundings commenced in Black River, from the Huron avenue bridge downward. The river was crowded with saw-logs, the remains of a jam occasioned by the flood of March 17, and the soundings had to be made by walking across the logs. According to instructions, soundings were made at the corners of every square of 20 feet, for which purpose a tarred line 200 feet long had been prepared, with cork floats 20 feet apart. All soundings in Black River were made with an 18-foot pole, graduated into feet and tenths.

Soundings in St. Clair River were commenced April 13, and were also made at intervals 20 feet apart, for a distance of 600 feet from shore, when we were compelled by the rapidity of the current, and the almost uninterrupted passage of vessels and rafts, to increase the intervals to 40 feet, or as near that as the buoys could be set.

Considerable annoyance and loss of time and material was incurred by the buoys and flags being run over and carried away by vessels, and, more especially by rafts, which, at times, floated down the river in an almost uninterrupted string. The soundings in St. Clair River were carried out to the 18-foot curve, covering an area of about 80 acres.

In the absence of any authenticated high or low water mark, the soundings were all referred to the 1-foot mark of the water-gauge, set up at the lower end of the ferry dock, which corresponds, as near as could be gathered from the testimony of river men, to the average stage of St. Clair River. It is 5,566 feet below the bench-mark on the northwest corner of the chimney of Hibbard's saw-mill. It was asserted by some river men that the water had been known as much as two feet lower and also two feet higher than this mark, but the only point known to be bare at low water, which was pointed out to us, was one foot below the assumed level. The water, during our stay, varied from 0.65 above to 0.5 below the 1-foot mark.

The difference in the level of the water at the ferry dock and at Fish's old dock, a distance of 3,500 feet, is 0.428 feet, giving a fall of 0.645 feet per mile.

The only observation for velocity taken was about 250 feet from shore. The float, submerged 6 feet, passed over 1,684 feet in six minutes 32 seconds, equivalent to a mile in 20 minutes 29 seconds. Further out the current is far swifter, but a continuous rain, on the only day we could spare for these observations, prevented us from obtaining further data.

The bottom of Black River, as found by boring, consists of a soft gray mud, with very fine sand in about equal proportions, for a depth of four feet, overlaid by eight inches of coarse sand.

All over the "middle ground," in St. Clair River, nothing was found but clear coarse gravel, which the auger could not bring up, but is plainly visible in clear weather On the new railroad dock fine mud, with some little fine sand, was brought up from the bottom. The surveys and examinations were completed on May 4; the party discharged, and myself, with Mr. Cram, returned to Detroit.

In its ordinary stages Black River has little or no current, and what little deposits it carries along are found near shore, below its mouth, in the shape of fine mud, as shown in the borings at the new railroad dock. Nothing of this kind was found on the "middle ground," which consists wholly of sand and coarse gravel, the washings of the shores above. But in times of high water the current of Black River is very swift, and pushes far out into St. Clair River, checking its current and thus causing it to deposit the materials which otherwise might be carried into Lake St. Clair. There can be no doubt that the action of the Black River current has thus formed the large flat known as the "middle ground," and is still annually increasing it. The charts of the lake survey of the years 1858 and 186–, compared with the map of the present survey, plainly show its increase in horizontal as well as vertical extent. If the whole of the "middle ground" was removed it undoubtedly would form again in the course of time, unless the current of Black River, at present nearly vertical to that of St. Clair River, is deflected so as to enter the latter in a nearly parallel direction.

To the general commerce of the lakes the existence of this "middle ground" can scarcely be said to be any obstacle. There is ample depth in the middle of St. Clair River and toward the Canada shore, and an easy approach to the natural port of Port Huron, which is above the mouth of Black River, and not threatened by any increase of the "middle ground." The only damage occasioned to general commerce by its existence occurs when vessels are driven to shelter in St. Clair River by northern storms in Lake Huron, when some hundred of them may come flying in, and be crowded, perhaps, in night time on the shoals of the "middle ground."

To remove the "middle ground" to a depth of 15 feet would require dredging of 168,300 cubic yards of gravel, covering an area of 46.6 acres; and to a depth of 18 feet, 393,800 cubic yards, on an area of 82 acres. The latter would probably be required if a safe anchorage must be afforded to the larger class of propellers in stormy weather.

The local interests of Port Huron, or that part of it below the mouth of Black River, would be amply served by an excavation along shore 300 feet wide to a depth of 15 feet, involving the dredging of 75,300 cubic yards.

As before stated, however, no permanent benefit could be derived from either of these excavations, unless accompanied by a change of direction of the mouth of Black River. To effect this a dam should be built obliquely across the mouth, from Hibbard's mill to White's dock, a distance of 500 feet, in water averaging 9 feet deep, and a new channel dredged, for the mouth of the river, 1,200 feet in length and 200 feet in width, to a depth of ten feet in clay and mud, say, 88,900 cubic yards. This would bring the current of Black River into St. Clair River in a parallel direction, and leave the current of the latter unchecked.

A map of the survey of the "middle ground," on a scale of $\frac{1}{1000}$ was commenced in May, but its completion unavoidably delayed by the absence of Mr. Cram and myself, on other duties.

Respectfully submitted.

H. A. ULFFERS,
Civil Engineer, Assistant.

Major O. M. POE, *Corps of Engineers U. S. A.*

The map referred to in the report has since been completed, and a copy of it upon a scale of $\frac{1}{5000}$ is herewith transmitted.

I fully agree with Colonel Ulffers in regard to the process of formation of the shoal known as the "middle ground," and think the measures he recommends for its removal the only practical ones. But the formation of the shoal goes on more rapidly now than formerly. This is due to to the more rapid degradation of the shore between the town of Port Hudson, and the Grand Trunk Railway depot. Much of this is due to the direction of the Grand Trunk wharf, which is such as to direct the very rapid current of the river against the bank below the south end of the wharf.

The following estimate of the probable cost of building the dam across Black River, and dredging out a new channel, is submitted, viz:

For 500 lineal feet of sheet-pile bulk-head, at $15 per lineal foot	$7,500 00
For 88,900 cubic yards, dredging at 60 cents per cubic yard	53,340 00
	60,840 00
Add 10 per cent. for contingencies	6,084 00
Total	66,924 00

This estimate is a liberal one so far as the cost of the work is concerned. But the land required in obtaining an outlet will be quite expensive, and as the amount is unknown, and cannot even be approximated in an estimate, it is omitted.

The cost of removing the "middle ground" is estimated as follows:

To obtain 15 feet of water over an area of 46.6 acres, 168,300 cubic yards dredging, at 40 cents per cubic yard,	$67,320 00
To obtain 18 feet of water over an area of 82 acres, 393,800 cubic yards dredging, at 40 cents per cubic yard	157,520 00

These estimates, again, are liberal; I deem them sufficiently so to cover all contingent expenses.

The estimate for the entire work of changing the direction of the outlet of Black River, and dredging so as to get 15 feet of water, would be—

Changing direction of outlet	$66,924 00
Dredging	67,320 00
Total	134,244 00

And to get 18 feet of water—

Changing direction of outlet	$66,924 00
Dredging	157,520 00
Total	224,444 00

And to do the work economically and well, the entire amount should be appropriated in one sum.

The nearest light-house is known as Fort Gratiot light.

The locality is immediately abreast a portion of the city of Port Huron, in the collection district of Huron.

The amount of revenue collected at Port Huron, for the fiscal year ending June 30, 1871, was $113,657 73.

The number of vessels (exclusive of barges and scows) which passed Fort Gratiot light in daylight, of week days, during the fiscal year was	16,833

Add 100 per cent. for vessels passing on Sundays and nights, and for barges and scows, and for vessels from below which passed the "middle ground," but did not go up as far as the light	$16,933
Total vessels passing the "middle ground"	33,866

But statistics which relate to Port Huron, alone, have little bearing upon the case. From the large number of vessels reported above as passing, it is seen that the entire commerce between upper and lower lake ports is interested.

All of which is respectfully submitted.

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

C 6.

REPORT CONCERNING THE IMPROVEMENT OF CLINTON RIVER, MICHIGAN.

By letter from the Chief of Engineers, dated July 18, 1871, and received on the 20th, I was informed that by act of Congress approved July 11, 1870, the sum of $5,000 had been appropriated, "For improvement of Clinton River, Michigan," and I was instructed to submit, at as early a day as practicable, a project for the prosecution of the work. Accordingly, on the 23d of July, I submitted the following project:

UNITED STATES ENGINEER OFFICE,
Detroit, July 23, 1870.

SIR: Inclosed herewith I transmit a small sketch, upon a scale of $\frac{1}{10000}$, of the mouth of Clinton River, Michigan, and have indicated upon it such improvement as it is probable can be made with the appropriation of $5,000 available.

The project contemplates dredging an 8-foot channel, nearly straight out from the mouth of the river, with a width of 50 feet at the bottom, and 100 feet at the top. If a greater width is given to the cut, the appropriation will not be sufficient to give an 8-foot channel, as the amount of material to be removed in making such a cut is about 17,385 cubic yards; indeed it is doubtful whether the bids will be sufficiently low to warrant undertaking to make a channel of 8 feet. One of 7½ feet will require the removal of 15,000 cubic yards, and one of 7 feet, 12,800 cubic yards.

I take it for granted that the width of the cut as proposed is the smallest allowable, and yet I deem it sufficient for the commerce of the place; the only question then is concerning the depth.

I therefore respectfully recommend that the cut be made 50 feet wide at bottom, and 100 feet at top, at the shoalest points, and dredged to such uniform depth as the funds available will allow. In the absence of a more detailed survey, the sketch inclosed is the best I have been able to obtain, and as I have no duplicate of it, I have respectfully to request that it be returned with the reply of the Chief of Engineers.

I also inclose a copy of the advertisement I propose to make in case the foregoing recommendation is approved.

I am not familiar with the routine in the matter of advertising, and therefore have to request that if the proposed advertisement requires the approval of the War Department, that it be forwarded for that purpose.

I think two weeks' notice of the time at which the proposals are to be opened quite sufficient, and it is now so late in the season that much more cannot be given without causing bidders to name a higher price for the work.

If the project is approved I will require $2,500 during the month of August, and $2,500 in September.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

Brevet Major General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

Which was duly approved by the Chief of Engineers as follows:

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., July 26, 1870.

GENERAL: Your project of operations for the improvement of the mouth of Clinton River, Michigan, as set forth in your letter of the 23d instant, is approved, and you are authorized in your advertisement for proposals to reduce the number of days' notice to fourteen.

The sketch accompanying your letter is herewith returned.

Very respectfully, your obedient servant,

By command of Brevet Major General Humphreys:

JOHN G. PARKE,
Major of Engineers, and Brevet Major General, United States Army.

Brevet Brigadier General O. M. POE,
Major of Engineers, Detroit, Michigan.

Proposals for the work were invited by advertisement dated August 1, 1870, and were duly opened on the 31st. The following is an abstract of all received:

Bidders' names.	Price of dredging measured—		Time to—	
	In banks.	In scow.	Commence.	Complete.
John Brown, Detroit, Mich.	27 cts. per cubic yard	22 cts. per cubic yard	Sept. 20, 1870	Nov. 1, 1870
Caskin & Stickney, Detroit, Mich.	29 cts. per cubic yard	22 cts. per cubic yard	Sept. 10, 1870	Dec. 1, 1870
Alanson Dodge, Skaneateles, N. Y.	44 cts. per cubic yard	34 cts. per cubic yard	Sept. 15, 1870	Dec. 1, 1870

Deeming the offer of Mr. John Brown to do the dredging required for 22 cents per cubic yard, measured in the scows, to be the most advantageous for the Government, I recommended its acceptance, and was authorized to enter into contract with him accordingly.

The work was taken in hand by Mr. Brown, but owing to circumstances explained in the following correspondence, it was found necessary to extend the time of completion.

SIR: Mr. John Brown, contractor for the improvement of Clinton River, Michigan, has just been in to say that he has encountered unexpected difficulty in the work; the dredging being harder than anticipated, and the shallow water on the bar making it both tedious and difficult to manage the dumping-scows. He has reached the shallowest part, (only 3½ feet of water.) The effect of this will probably be to protract the work beyond the 1st of November, the date named on his bid as that upon which the work was to be completed. He states that he intended to say the 1st December.

Inasmuch as the contract provides for the completion of the work on the 1st November, I request to be instructed whether this extension to the 1st December can be permitted. A channel will be available by the 1st of November, or before; but the entire work will not be completed.

I have been at the work, and know that the condition of things reported exists so far as the depth of water is concerned. Until a channel is made through, available for the dumping-scows, I don't exactly see how the work can be pushed more rapidly, and I respectfully recommend the extension of time named.

I am, sir, very respectfully, your obedient servant,

O. M. POE,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army.

P. S.—Two thousand six hundred and twelve cubic yards had been excavated and removed up to Saturday evening, the 15th instant.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 22, 1870.

MAJOR: Your letter of the 18th instant is received. You are authorized, for the reasons stated, to extend the time for the completion of the contract of Mr. John Brown for the improvement of Clinton River, Michigan, from the 1st November to the 1st of December, 1870.

Very respectfully, your obedient servant,
By command of Brigadier General Humphreys:

JOHN G. PARKE,
Major of Engineers.

Major O. M. POE,
Corps of Engineers, Detroit, Michigan.

The work progressed well until its completion, the resulting channel being as follows:

	Feet.
Length	2,700
Average width at top	98
Average width at bottom	58
Depth of water at stage of 1st December, 1870	9

Amount of material removed, 20,454 cubic yards, and the cost being for—

Dredging	$4,499 88
Superintendence	319 00
Advertising	21 00
Office and incidental expenses of all kinds	159 52
Total	5,000 00

The channel obtained is a better one than I expected, and thus far has given satisfaction. I counted upon the rapid filling of the cut by drift-sand brought into it by the southwestward current setting directly across it. But this has not been as serious as I supposed it would be, and the channel is in daily use, without complaint that I have as yet heard from any source.

By act of Congress, approved March 3, 1871, the sum of $1,500 is appropriated for this work. It is proposed, before the close of this season, to make a detailed survey of the improvement, with a view to determine its present condition, and the measures necessary to maintain its efficiency.

The nearest port of entry is Detroit, Michigan, situated in the collection district of Detroit. The nearest light house is at St. Clair Flats.

The amount of revenue collected at Detroit for the fiscal year ending June 30, 1871, was $270,053 08, and the revenue collected at Clinton River, for same period, was $11, and the number of vessels entering from, and clearing to, ports beyond the district was 133. Much the greater portion of the trade at Clinton River is carried on with ports in the same collection district, and vessels engaged in it are, by act of Congress approved July 1, 1870, relieved from the necessity of reporting and clearing. Hence accuracy of the statistics of the commerce of the place given above is limited as indicated.

All of which is respectfully submitted.

O. M. POE,
Major of Engineers, and Brevet Brigadier General, U. S. A.

C 7.

UNITED STATES ENGINEER OFFICE,
Milwaukee, Wisconsin, December, 1870.

GENERAL: I have the honor to report that, in compliance with letter dated Office of the Chiefof Engineers, Washington, D. C., July 23, 1870, I caused a survey to be made of the harbor at Cheboygan, Michigan, and would respectfully submit the following report, plans, and estimates for the improvement of the mouth of the Cheboygan River.

Cheboygan is situated at the mouth of the river of the same name, which empties into the Straits of Mackinaw, just south of Bois Blanc Island. The following extract from the report of Roys J. Cram, civil engineer, made in 1869, gives a good idea of the locality and country about the tributaries of the Cheboygan River:

CHARACTER, EXTENT, AND IMPORTANCE OF THE CHEBOYGAN RIVER, MICHIGAN, AND PRESENT BUSINESS UPON IT.

Having made a reconnaissance of this water-course as far up as into Burt Lake, I am prepared to speak with my own knowledge upon the subject. It is seen that this river discharges the waters of several tributary streams and small lakes into Mackinaw Straits to the south of Bois Blanc Island, which affords protection to vessels steering for the mouth of the river.

The extent from the mouth 1,500 feet up to the bridge, can, by dredging, be well adapted for an inner harbor for a large business. From the bridge up the river holds its width, and is equally adapted for navigation and business, until we reach a point one and one-fourth miles above the town, where there is a rapid or fall, giving a large and valuable water-power. This rapid has been improved by a company under a charter from the State of Michigan, with a lock suitably constructed, where there are in operation extensive and well-constructed mills of various kinds. A short distance higher up the river an extensive shingle factory is being built and will soon be put in operation; and as we ascend still higher, several mill-sites have been recently purchased, with booming privileges, for the erection of other mills. Even the small island in the straits has recently been purchased for the erection of a large lumber-mill upon it, using the water in the bay for booming the logs.

From the rapids, all the way up into Mullet and Black Lakes, the navigation is excellent; water is in abundance, and the banks are covered with prosperous farms in good cultivation.

The lakes are beautiful, deep, of clear water, and their banks without marshes. The soil all around them is good for farming purposes. Farms are already opened on both sides of Mullet Lake. Indian River, connecting Mullet and Burt Lakes, is deep and crooked, though easily navigated by a steamer; its banks, for some width, are covered with marsh grass and cedars. Just at the outlet of Burt Lake, and thence down for three-fourths of a mile or more, the current in Indian River is swift and the water is shoal, indicating a rapid fall down to the confluence of Sturgeon River. To improve this rapid would require a dam and lock; the dam to raise the water of the river to the level of the lake.

And the shoal part of the lake, just above its outlet, should be improved by constructing two parallel dikes and dredging between them. We could thus produce as deep a draught for steamers as would be required without drawing down the lake. After once being fairly in Burt Lake, there is found good navigation all the way to its head. Its banks afford excellent timber and farming lands. The Indian reservation in its vicinity is of much value. The navigation is continuous from Burt Lake by river into Crooked Lake, and thence again by river to within three-fourths of a mile of Little Traverse Bay of Lake Michigan. Through this portage it would not be difficult to open a canal, I am credibly informed; and that being opened properly, we should have a continuous navigation between Lake Michigan and the Straits of Mackinaw for an extent, by the rivers and lakes just described, of about forty-five miles.

The principal tributaries of this water-course are Maple River from Douglas Lake, Sturgeon River, Pigeon River, and Black River. All these run through excellent land, now bearing heavy growths of soft and hard pine, birch, maple, beech, cedar, &c., and the greater part would be good, when cleared, for farming purposes.

All these rivers are of ample width and depth for running down long timber and saw-logs from the extremities of the branches. Logs are now run for an extent of forty-five miles in Pigeon River. The circumstances are so favorable for running logs in these rivers, that the pine and cedar lands upon them, or even at as great a distance as five miles back from them, are very valuable. The pine on these streams is of a quality to make lumber and timber, which commands the highest price in Chicago market. A large portion of the land in the five counties is of a soil very good for farming purposes, and settlers are entering on them for these purposes, especially in Cheboygan County.

The proximity of so much lake-water renders the climate much milder than is generally supposed in winter. The wheat that is grown (and it is grown with perfect success on the farms of the Cheboygan River) ranks with the highest grades of northwestern wheat in the markets. And these farms produce in abundance rye, grass, oats, potatoes and other vegetables, and the "eight-row" corn. The outlet of one whole county and parts of four more counties, for their products, is through Cheboygan River.

In the water-courses described there is no sand to form bars; the banks are generally tolerably high and remarkably free from marshes, and consist of a reddish-colored clay and loam. Owing to the constant supply from the lakes, the Cheboygan River has no very low stages, but always a sufficiency of water for navigation.

The present business on the river is quite extensive in timber, lumber, lath, and shingles, cedar telegraph poles and fence posts, cord-wood of maple, beech, and birch, farm products, and store traffic. The cord-wood is taken out upon scows, corded on the docks, which are built in deep water, and there sold to steamers passing through the great lakes. The United States custom-house of the port is on one of these docks. Owing to the shoalness of the water in the straits, between the docks and the mouth of the river, vessels are obliged to lie off at or near them, to load and unload by the intervention of lighters, when drawing over 6½ to 7 feet.

The population of the town and county probably numbers from three to five thousand of fixed settlers, not including the Indian settlements on Burt Lake. The number of residents is fast increasing by immigration since the good quality of the soil for farming purposes has become known. The back farming and great lumbering facilities must, in a few years, make Cheboygan a large and flourishing town, where property will be valuable to own. Could vessels drawing 12 feet run into the river, this site would become of great importance to the general lake commerce. There should be a dry-dock constructed here to relieve damaged vessels from the necessity of running all the way from that part of the lakes to Chicago or Detroit for repairs. It would be a place admirably adapted for a large smelting iron establishment, owing to the facility of bringing the ore from Lake Superior, and the vast quantities of wood, and its cheapness for smelting. It would be also a very favorable site for the manufacture of brick, drain-pipes, tiles, and pottery, the clay being of an extraordinarily fine quality, and coming up to the very surface of the ground. When a railroad is constructed, which will ere long be done, coming up from the southern part of the State, it will pass in the vicinity of Cheboygan, if not close to it; then it will become one of the best places known for an extensive tannery, as vast quantities of excellent bark are in the immediate vicinities that can be brought by water; but as hides require facilities for winter transportation, for profitable tanning business a railroad communication would be necessary for this branch of business. But notwithstanding all the foregoing described natural advantages of Cheboygan, one can see with half an eye, that its future growth and permanent prosperity must depend upon an improvement of its harbor. Until this improvement is made it will be an up-hill struggle for the town to become large and prosperous, and the sales of the vast amount of good farming land, yet belonging to the United States in this region, will be comparatively slow.

There is no need of any harbor of refuge for the general commerce of the lake, but there seems to be much need of some place of resort for vessels disabled by storms or accidents in this vicinity. At the present time vessels disabled in the Straits of Mackinaw are either towed to Milwaukee or Detroit for repairs, thereby causing a great loss of time and money. There is no doubt that an accessible harbor at this place for all vessels plying the lakes would tend to develop a large extent of country now undeveloped for want of facilities for shipping produce and lumber. Should this harbor be improved I would recommend the following plan:

From a line drawn from A^1 (see accompanying tracing) I would dredge out a channel 200 feet wide and 14 feet deep, following the natural channel of the river as far as it defines itself and thence in a direction perpendicular to the general direction of the shore line. The amount of earth to be dredged would be 278,080 cubic yards, at 40 cents per cubic yard, $111,232.

This channel I would revet from *A* to *B*, on west pier, and from A^1 to B^1, and east pier by a sheet-pile pier. The details of this pier are shown in the accompanying tracing. The total length of this sheet-pile pier would be 4,150 feet.

The cost of which would be as follows:

16,600 linear feet 12 by 15 inches pine timber, at 19 cents per linear foot	$3,154	00
10,400 linear feet 12 by 15 inches pine timber, at 15 cents per linear foot	1,560	00
8,300 linear feet 6 by 12 inches pine timber, at 9 cents per linear foot	747	00
36,500 linear feet piles, at 9 cents per linear foot	3,285	00
736,560 feet (board measure) plank, (sheet piles,) at $12 50 per thousand	9,207	00
20,763 pounds drift-bolts, at 4 cents per pound	830	52
39,393 pounds nut and screw bolts, at 6 cents per pound	2,363	58
19,921 pounds 8-inch spikes, at 7 cents per pound	1,394	47
3,631 cords of brush, at $3 per cord	10,893	00
Driving 1,040 piles, at $2 per pile	2,080	00
Driving 11,125 sheet piles, at $1 per sheet pile	11,125	00
Framing 35,300 linear feet timber, at 13 cents per linear foot	4,589	00
	51,228	57

From B B^1 to pier-head crib (3,000 feet) I would protect the channel with a close-pile pier. The total length of the close-pile pier would be 6,000 feet, which, in detail, would cost as follows:

97,250 linear feet 12 by 12 inches pine lumber, at 15 cents per linear foot	$14,587	50
12,000 linear feet 10 by 12 inches oak timber, at 30 cents per linear foot	3,600	00
12,000 linear feet 4 by 8 inches oak timber, at 8 cents per linear foot	960	00
337,500 linear feet piles, at 9 cents per linear foot	30,375	00
151,785 pounds iron drift-bolts, at 4 cents per pound	6,071	40
123,990 pounds screw-bolts and washers, at 6 cents per pound	7,439	40
4,687 cords of stone, at $12 per cord	56,244	00
9,750 cords of slabs or brush, at $3 per cord	29,250	00
Driving 11,250 piles, at $2 per pile	22,500	00
Framing 97,250 pine timber, at 13 cents per linear foot	12,642	50
Framing 24,000 oak timber, (under water,) at 29 cents per linear foot	6,960	00
	190,629	80

The ends of the piers should be protected by pier-heads built of cribs 32 feet square in plan and 20 feet high, costing as follows:

10,456 cubic feet pine timber, at 15 cents per cubic foot	$1,568	40
12,508 pounds iron drift-bolts, at 4 cents per pound	500	32
3,152 pounds screw-bolts and washers, at 6 cents per pound	189	12
224 cords of stone, at $12 per cord	2,688	00
Framing 10,456 cubic feet timber, at 13 cents per cubic foot	1,359	28
	6,305	12

RECAPITULATION.

For dredging	$111,232 00
For sheet-pile pier	51,228 57
For pile-pier	190,629 80
For pier-heads	6,305 12
	359,395 49
For superintendence and contingencies	35,939 54
Total	395,335 03

The pile-piers are proposed because the bottom into which the piles are to be driven is of stiff clay.

The width of the channel is made 200 feet to conform to the general rule observed at other places. It might be that a channel of 100 feet in width would do for the present, but the revetments should be placed 200 feet apart, so that if at some future time it should be thought desirable to widen the channel, no new revetments need be constructed. The dredging would thus be reduced one-half, making a difference in the total estimate of $61,177 60—leaving the estimate $334,157 43.

It would take three seasons' work to complete this improvement, and if the plan proposed is adopted, at least $150,000 should be appropriated for the first season's work.

I have not recommended any dredging inside of the mouth of the river, as it should be done by the local authorities, nor have I made any estimate for protecting the river banks, for, should the Government make such improvement, it would be equivalent to presenting the landowners with so much dockage.

The amount of dredging that would be necessary to make a channel and winding place for vessels, interior to the proposed work, would amount to 55,086 cubic yards, which at the estimated price, 40 cents per cubic yard, would cost $22,034 40.

I have the honor to be, very respectfully, your obedient servant,

F. U. FARQUHAR,
Captain Corps of Engineers, U. S. Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

***Statement** of vessels entered and cleared at Cheboygan Harbor, in the district of Michigan, during the year 1869, showing the aggregate number, tonnage, crews, and cargoes.*

Articles.	Entered.	Articles.	Cleared.
Number of vessels	220	Number of vessels	225
Number of tons	41,834	Number of tons	43,719
Number of crews	1,401	Number of crews	1,493
Cords of bark	500	Lumber (M feet)	3,998
Bushels of wheat	9,692	Lath (M feet)	125
Bushels of corn	12,835	Shingles (M)	123
Bales of hay	259	Timber (M feet)	1,421
Barrels of flour	1,239	Railroad-ties	800
Barrels of pork	137	Fence-posts	1,000
Barrels of beef	8	Barrels of flour	100
Barrels of salt	34	Barrels of fish	545
Barrels of apples	150	Salt-barrels	49,070
Bushels of potatoes	73	Telegraph-poles	4,850
Heads of live stock	3	Bushels of barley	311,241
Packages of merchandise	405	Salt-bags	2,500
		Tons of iron	1,794
		Packages of merchandise	664

O 8.

Annual report of T. J. Cram, (retired) colonel of engineers, for fiscal year ending 30th June, 1871. Improvements of St. Clair Flats, Michigan, consisting of the construction of the St. Clair Flats Ship-Canal.

From assurances of the contractor it was confidently expected that this work would be completed and formally opened for the lake commerce on or before the 1st of August, 1870.

Owing, however, to his miscalculations, the sending of three of his dredges away to other works, and some bad luck, his dredging for grading the bottom of the canal down evenly to the prescribed depth was protracted so late into last autumn, that it was impossible to make all tht test soundings before the last of February, 1871.

After that, all these carefully-made soundings had to be reduced, plotted, and computed; and it was found from them that there remained a total of 30,921 cubic yards yet to be dredged—in all the several places where a deficiency was shown in the dredging—necessary to bring the bottom of the canal everywhere down to the requisite depth according to the terms of the contract.

Accordingly the contractor was directed to resume as early as possible and dredge out this amount; also to dredge out flaringly on the sides of the head and tail bays of the canal to the amount of 9,395 cubic yards, so as to leave the upper and lower ends of the canal 416 feet wide at bottom, while the part between the dikes is 300 feet wide.

In passing, I will remark that this is the widest known artificial canal. The Suez construction, in the artificial parts, does not, I am informed, exceed 250 feet at the water surface, and there is none known carrying so much commerce as the United States St. Clair Flats Canal is to accommodate.

The contractor resumed dredging for the purposes above named the 10th of April, and has steadily persevered, so that on the 27th June the inspector reported that all the forenamed amounts of dredging into ten to twelve days' works had then been accomplished.

During this fiscal year, under the act of July 11, 1870, specifically appropriating $16,500 for this work, a contract was made for sodding, sowing grass-seed, planting willows upon the banks, and riprapping with stones under water around the faces and corners of the wings of the canal-dikes. All this work, except the small spots occupied temporarily by the contractor's buildings, has been reported by the contractor as having been done.

Notwithstanding the failure to complete the canal by the time promised, nearly a year since, it was freely used by vessels when necessary for safety during last season; so it has been during the present season of navigation. But from prudential motives the canal has not been officially declared open, and it is yet in possession of the contractor; nor will it be accepted, nor will the contracts be closed and the retained per cent. be paid, until all shall have been completed according to the terms of the contracts.

I think, however, all will be satisfactorily completed by the 31st July, 1871, and accepted, and the canal on or before that time declared open to the commerce of the lakes. The amount expended during the fiscal year from the appropriation "repairs, preservation, extension, and completion of river and harbor works," is $70,042 87.

The amount expended from the specific appropriation of $16,500, act

11th July, 1870, is $8,326 36. Total expended on the work this fiscal year, $78,369 23. Of the first sum, $11,514 88 has been paid in retained per cent. on contracts for materials which were closed; and $58,527 99 has been for materials and work and per cent. yet due on the contract for work.

Of the second sum, $7,955 has been paid for work done and services of employés, &c., and $371 36 is retained per cent. under the contract of 11th November, 1870.

Out of the two appropriations named, there will be enough left to complete the work as prescribed in the contracts and pay the contractor all the retained per cent. that will be due him when the work is accepted, and pay the employés; leaving the work untrammeled with debt, affording an example of a large work having been completed within the original engineer's estimate.

Probable estimate of funds required to be appropriated for the fiscal year ending 30th June, 1872.

For wages of the custodian of the canal	$1,500
For contingencies that may occur in the shape of necessary repairs	1,000
Total	2,500

All of which is respectfully submitted.

T. J. CRAM,
Retired Colonel Engineers,
Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

1817 DE LANCY PLACE, PHILADELPHIA, *June* 30, 1871.

C 9.

EXAMINATION AT PINE RIVER, SAGINAW BAY, MICHIGAN.

The lake survey having in 1857 been extended beyond this point, I have deemed it unnecessary to make a resurvey of the locality, and submit herewith a tracing of the detailed chart of that point, and vicinity; scale, $\frac{1}{10000}$, upon which is indicated, by red parallel lines, the improvement which should be made in case anything is done.

Pine River is a small stream emptying into Saginaw Bay on its northern side. The river itself had, at the date of the survey, about 7 feet in depth for a width of less than 100 feet, with only 4 feet on the bar. From 7 feet in the river, to the same depth outside, the bar was at that time about 3,000 feet, and I have no reason to think that, making allowance for the higher stage of water at present, the circumstances are at all changed for the better. A channel to be of any use at all will have to be made at least 50 feet wide at the bottom, and 100 feet at the top, at the shoalest water on the bar, and 7 feet in depth at the stage of the survey. This will involve the removal, by dredging, of 15,000 cubic yards of sand, at an estimated cost of 50 cents per cubic yard, or a total of $7,500.

The estimate may seem high, but it is 29 cents per cubic yard less than was paid for dredging the channel at the mouth of Saginaw River, and should this prove to be as difficult, the price of 50 cents per cubic yard will be found entirely too low instead of too high. I have not estimated for piers of any kind, since the expenditure of the large amount of money required to build them is unwarranted by the commerce of the place.

The harbor, if made, can be of no general importance, and is not required as a harbor of refuge. Neither would it be possible for a vessel finding the anchorage outside dangerous to enter in a gale of wind.

The point has only local consequence, and in any of the rare cases, when a vessel would be driven from the anchorage outside, a harbor is easily made at Tawas, Wild Fowl Bay, or Saginaw River, neither of which is more than thirty miles distant.

I may remark, that from the middle of August to the latter part of October, 1857, I was on board of the little steamer Surveyor, at work on this portion of Saginaw Bay, and on no occasion was I driven from my anchorage, although in several gales, and generally in more exposed positions off the points where triangulation stations were built.

Respectfully submitted.

O. M. POE,
Major of Engineers.

APPENDIX D 1.

REPORT UPON THE IMPROVEMENT OF MONROE HARBOR, MICHIGAN.

The improvement of this harbor, and of the harbors on Lake Erie, west of Dunkirk, was under charge of Major Walter McFarland, Corps of Engineers, United States Army, until April 25, 1871, since which time of Captain G. L. Gillespie, Corps of Engineers, United States Army.

Work of dredging, under the contract with Thomas Dunbar & Co., of Erie, Pennsylvania, dated August 30, 1869, was continued to October, when the contract was completed. Eight thousand cubic yards of sand were removed from the bar at the mouth of the ship canal, and there is now a good 12-foot channel into and through ship canal, and into the river. In regard to further improvement of this harbor, see report of resurvey of Monroe Harbor, accompanying this report.

Balance June 30, 1870	$6,253 71
Expended during the year	6,101 60
Balance June 30, 1871	152 11

The amount annually required to keep piers in repair is probably about $800. This harbor and port are in the collection district of Detroit, near Monroe light, a fixed white light of the fourth order.

The amount of duties collected during the fiscal year ending June 30, 1871, $54 45.

Number of entries and departures, 82; aggregate tonnage, 10,629.

D 2.

REPORT UPON THE IMPROVEMENT OF MAUMEE BAY, TOLEDO, OHIO.

The work of improving the western channel through Maumee Bay, under the contract made with Patrick Smith, of Cleveland, Ohio, dated August 11, 1869, was continued to November 6, 1870, when the dredges were removed for the season, up to which time the entire amount of sand removed was 73,653 cubic yards. Patrick Smith resumed work April 25, 1871, with two dredges, and up to the time of the completion of his contract, June 7, had removed from the western channel about 86,000 cubic yards of sand and clay. An appropriation for $50,000 was made July 11, 1870, for the further improvement of the harbor. Sealed proposals were publicly invited to February 15, 1871, for the removal of 120,000 cubic yards from the same channel, and a contract was made with Alexander Spalding, of Buffalo, New York, the lowest bidder, March 3, 1871, at 21 cents per cubic yard, amounts so removed to be determined by soundings and measurements made before and after dredging, with an allowance to the contractor of $25 per day for each dredge when prevented from working by rough and windy weather only. (See abstract of proposals accompanying this report.) Andrew Spalding commenced work under his contract with two dredges on May 20, 1871, and up to the close of the fiscal year has removed 36,691 cubic yards of sand from the main channel. Spalding will continue his operations between the red and black can buoys of the main channel, now 60 feet wide, until he has attained throughout a depth of 14 feet of water at low stage, afterward he will widen the channel to the limit of available funds.

An appropriation of $50,000 was made March 3, 1871, for the further improvement of the harbor. Sealed proposals were publicly invited to May 25, 1871, for the removal of 200,000 cubic yards, more or less, of sand from the main channel, at such points as the engineer in charge should direct, and a contract was made with Charles Fitzsimons, of Chicago, Illinois, the lowest bidder, June 6, at 30 cents per cubic yard, measurement to be made in the bed of the channel. (See abstract of proposals accompanying this report.) He will commence work early in July and will be assigned to that part of the main channel between the red can buoy and the 14-feet curve in the direction of Turtle Island.

Balance on hand June 30, 1870		$11,724 23
Amount drawn October 1, 1870		10,000 00
Appropriated July 11, 1870		50,000 00
Appropriated March 3, 1871		50,000 00
Total		121,724 23
Expended during year	$20,844 92	
Due June 30, 1871	15,087 89	
		35,932 81
Balance June 30, 1871		85,791 42

Which balance will be expended by June 30, 1872. Still required to complete improvements as ordered, $20,000.

Toledo Harbor (Maumee Bay) is in the collection district of Miami, near the port of Toledo, Ohio. The nearest light is a fixed white of the fourth order, shown from Turtle Island.

The amount of revenues collected here during the fiscal year ending June 30, 1871, was $49,289 35. Number of entries of vessels during the same period, 2,178; and departures, 2,148, with an aggregate tonnage of 982,593.

Abstract of proposals for improving Toledo Harbor, Ohio, opened at Buffalo, New York, May 25, 1871.

Names of bidders.	Per yard.*	Per yard measured in bank.	Per yard measured in scows.	Detention of each dredge for stress of weather per day.	Detention of each tug for stress of weather per day.	Description of work.
	Cents.	*Cents.*	*Cents.*			
Smith & Sims, Cleveland, Ohio	35			$30		Removing from main ship-channel 200,000, more or less, of sand and clay.
Clark & Douglass, Chicago, Ill	43					
O. J. Jennings & Co., Syracuse, N. Y.	37			35		
William Richardson, Chicago, Ill	32			30		
Do	42					
J. F. Hayden & Co., Chicago, Ill		35	29			
McNelly, Goulden & Stock, Toledo, Ohio.	35					
McNelly, Goulden & Stock, Toledo, Ohio.	25			25		
J. H. Ledlie & Co., Chicago, Ill			25	40	$25	
Fox & Howard, Chicago, Ill			34½			
C. Fitzsimons, Chicago, Ill		30				
N. G. Dodge & Bro., Cleveland, Ohio.	45					

* No condition specified as to measurement.

Abstract of bids for dredging the main ship channel through Maumee Bay, Ohio, opened at the United States Engineer Office, Painesville, Ohio, in accordance with the terms of an advertisement dated January 15, 1871.

Names of bidders.	Residence.	Rate per cubic yard.	Remarks.
Carkin & Kimball	Chicago, Ill	$0 30	Or 27.7 cents in scows, or $100 per day for dredge, tug, and scows.
Thomas M. Hubbell	East Saginaw, Mich	40	
Thomas Dunbar & Co	Monroe, Mich	35	Or $100 per day for each dredge and tug, and $60 per day when weather prevents work.
O. J. Jennings	Syracuse, N. Y	27½	Or 25.5 cents in scows.
Morris G. Dodge	Cleveland, Ohio	39	
Wells DeGraw	Fulton, N. Y	30	
William Richardson	Buffalo, N. Y	22	
E. R. Seward	Albany, N. Y	37	
Andrew Spalding	Buffalo, N. Y	21	And $25 per day when weather prevents work.
McNelly, Goulden & Stock	Toledo, Ohio	39	

D 4.

REPORT UPON THE IMPROVEMENT OF SANDUSKY CITY HARBOR, SANDUSKY, OHIO.

In accordance with the terms of his contract, dated September 10, 1869, Patrick Smith, of Cleveland, Ohio, commenced the work of dredging the inner channel of this harbor in July, 1870, and completed his contract in November, having removed 28,192 cubic yards of sand and clay in a cut 60 feet wide and 2,500 feet long.

For the further improvement of this harbor an appropriation of $10,000 was made July 11, 1870. Sealed proposals were publicly invited to February 15, 1870, for removing 25,000 cubic yards of sand, more or less, from the channel over the inner bar, in a cut half a mile in length and 90 feet in width, and a contract was made with O. J. Jennings, of Syracuse, New York, the lowest bidder, March 4, 1871, at 26½ cents per cubic yard, measured in bank. (See abstract of proposals accompanying this report.) O. J. Jennings commenced work with one dredge, May 13, 1871, and up to the close of the fiscal year has removed about 5,500 cubic yards of sand and clay. The progress made has not been satisfactory on account of many mishaps to the dredge from imperfect machinery and bad weather. It is hoped he will complete his contract by the 1st of November.

Balance June 30, 1870		$9,749 81
Appropriated July 11, 1870		10,000 00
Total		19,749 81
Expended during year	$10,604 56	
Due June 30, 1871	1,590 80	
		12,195 36
Balance June 30, 1871		7,554 45

No appropriation is recommended for the further improvement of the harbor.

Sandusky City is a port in the collection district of Sandusky, Ohio, near Cedar Point and Sandusky lights.

Revenue collected during the fiscal year ending June 30, 1871, $26,400. Number of entries, 1,070; number of clearances, 1,048; aggregate tonnage, 406,483.

Abstract of bids for dredging the channel over the inner bar, Sandusky Bay, Ohio, opened at the United States Engineer Office, Painesville, Ohio, in accordance with the terms of an advertisement dated January 15, 1871, *inviting proposals for the same.*

Names of bidders.	Residence.	Rate per cubic yard.	Remarks.
Thomas Dunbar & Co	Monroe, Mich	$0 40	Or 36.6 cents in scows, or $100 per day for dredge, tug, and scows.
Carkin & Kimball	Chicago, Ill	42.2	
O. J. Jennings	Syracuse, N. Y	26.5	Or 25 cents in scows.
N. G. Dodge	Cleveland, Ohio	41	
William Richardson	Buffalo, N. Y	30	
A. Spalding	do	28	And $25 per day when the weather prevents work.
P. Smith	Cleveland, Ohio	50	
E. R. Seward	Albany, N. Y	34	
McNelly, Goulden & Stock	Toledo, Ohio	50	

D 5.

REPORT UPON THE IMPROVEMENT OF HURON HARBOR, OHIO.

The operations at this harbor, commenced in the spring of 1870, by William Nicolls, of Detroit, Michigan, under contract dated October 14, 1869, were completed in September.

The piers are now in good condition, and the channel has full 15 feet depth of water at low stage.

Balance June 30, 1870	$12,551 52
Expended during the year	3,156 76
Balance June 30, 1871	9,394 76

Probable annual cost of keeping the piers in repair, $1,000.

Huron is a port in the collection district of Sandusky, Ohio, near the Huron beacon-light.

Revenue collected during the fiscal year ending June 30, 1871, $30. Number of entries, 34; number of clearances, 34; aggregate tonnage, 8,239. No appropriation recommended.

D 6.

REPORT UPON THE IMPROVEMENT OF VERMILLION HARBOR, OHIO.

No money has been available, for any improvement, during the year. The piers are in fair condition. It is probable that the shipping from this port has slightly increased during the year, but there is ample water in the channel-way to meet all the requirements of the commerce of the harbor. No appropriation is asked for any improvement. Probable cost of keeping piers in repair, $1,000.

Vermillion is a port in the collection district of Sandusky, Ohio, near Vermillion beacon-light. Duties collected during the fiscal year ending June 30, 1871, $102. Number of entries and departures for the same period 68, with an aggregate tonnage of 1,239.

D 7.

REPORT UPON THE IMPROVEMENT OF BLACK RIVER HARBOR, OHIO.

Nothing of any consequence has been done during the year. The piers are in good repair and the channel has 12 feet of water.

Balance June 30, 1870	$7,980 05
Expended during the year	66 00
Balance June 30, 1871	7,914 05

No further improvement of the harbor is required. Probably $1,000 annually will suffice to keep piers in repair.

Black River is in the collection district of Cuyahoga, Ohio, near the Black River beacon-light.

D 8.

REPORT UPON THE IMPROVEMENT OF CLEVELAND HARBOR, OHIO.

The head of the east pier which, was run into by a steamer in October, and badly injured, and which was further damaged by a storm in the same month, has been completely repaired from the water-line seven courses upward, using in this work 7,000 feet (board measure) timber and plank, 1,200 pounds of iron and spike, 20 cords of rubble-stone. The work was done by days labor. The decking of the east pier has been greatly injured by mariners during the year; the almost entire absence of snubbing-posts has made mariners resort to such parts of the pier as were attainable; most generally they have cut through the decking adjoining the side timbers and hitched on to the joists. Snubbing-posts will be put in and the piers repaired during July.

An appropriation of $20,000 was made July 11, 1870, for the further improvement of the harbor. Sealed proposals were publicly invited to February 15, 1871, for removing from the outer bar and from the channel between the piers 30,000 cubic yards, more or less, of sand, and a contract was made with Andrew Spalding, of Buffalo, New York, March 7, 1871, at 25 cents per cubic yard, with a further allowance of $25 per day for each dredge when unable to work on account of rough and windy weather. Work was commenced with two dredges June 3, with directions to make a cut 50 feet wide, in the middle of the channel, giving 18 feet water, and to extend the same from near the railroad swing-bridge to the 18-foot curve north of the end of the entrance piers.

When the 50-foot cut is completed, it will be widened on either side by two 20-foot cuts, giving respectively 17 and 16 feet water. This depth of water is very necessary; the entrance to the harbor is so exposed that during storms, with unfavorable winds, the depth of water on the outer bar has been known to be diminished 5 feet, a condition of affairs exceedingly dangerous now for vessels drawing more than 10 feet. Up to the close of the fiscal year about 9,500 cubic yards had been removed.

Balance June 30 1870	$2,420 00
Appropriated July 11, 1870	20,000 00
Total	22,420 00
Expended during year	2,628 45
Balance June 30, 1871	19,791 55

Cleveland is in the collection district of Cuyahoga, near Cleveland light and beacon.

During the year ending June 30, 1871, there was collected from duties at this port the sum of $173,409 03; number of entries and departures, 7,216; tonnage, 2,145,062.

Amount probably required annually to keep the piers in repair, $1,000. No further appropriation recommended.

Abstract of bids for dredging the bar and channel at Cleveland Harbor, Ohio, opened at the United States Engineer Office at Painesville, Ohio, in accordance with the terms of an advertisement dated January 15, 1871, inviting proposals for the same.

Names of bidders.	Residence.	Price per cubic yard.	Remarks.
Carkin & Kimball	Chicago, Ill	$0 42.2	Or 36.6 cents in scows, or $100 per day for dredge, tug, and scows.
O. J. Jennings	Syracuse, N. Y	29	And $1 per cubic yard for dredging old pier.
N. G. Dodge	Cleveland, Ohio	32	Or $95 per day.
W. Richardson	Buffalo, N. Y	26	
A. Spalding	do	25	And $25 per day when weather prevents work.
E. R. Seward	Albany, N. Y	30	
McNelly, Goulden & Stock	Toledo, Ohio	40	

D 9.

REPORT UPON THE IMPROVEMENT OF GRAND RIVER HARBOR, FAIRPORT, OHIO.

No work of improvement has been done during the year.

Balance June 30, 1870	$33,606 94
Expended during the year	77 70
Balance June 30, 1871	33,529 24

Probable annual cost of keeping piers in repair $1,500.

The east and west piers will be repaired and snubbing-posts added during the season. The work will be done by days' labor.

Grand River is in the collection district of Cuyahoga, Ohio, near Grand River light. The amount of revenues collected during the fiscal year ending June 30, 1871, was $455.

D 10.

REPORT UPON THE IMPROVEMENT OF ASHTABULA HARBOR.

Nothing has been done at this harbor during the year. An appropriation was made March 3, 1871, for $15,000 for the further improvement of the harbor. Sealed proposals were publicly invited to May 25, 1871, for removing from the channel, between the piers, about 7,000 cubic yards, more or less, of shale rock by blasting and dredging, so as to give a depth of 12 feet at low water, and a contract was made with Lee & Dunbar of Erie, Pennsylvania, June 17, 1871, at $2 25 per cubic yard. Work under this contract will commence in July. The 60-feet channel blasted out in 1869–'70 will be widened to the full distance between the piers.

Balance June 30, 1870	$150 22
Appropriated March 3, 1871	15,000 00
Total	15,150 22
Expended during the year	5 00
Balance June 30, 1871	15,145 22

No additional appropriation is recommended.

Amount probably required annually to keep piers in repair, $800.

Ashtabula Harbor is in the collection district of Cuyahoga, Ohio, near Ashtabula beacon-light.

During the fiscal year ending June 30, 1871, there was collected here from duties $100 49. Number of entries of vessels during the same period, 42. Number of departures, 43. Aggregate tonnage, 8,788.

Abstract of proposals for improving Ashtabula Harbor, Ohio, opened at Buffalo, New York, May 25, 1871.

Names of bidders.	Residence.	Per cubic yard.	Description of work.
Lee & Dunbar	Erie, Pa	$2 25	Removing from the channel between the piers 7,000 cubic yards, more or less, shale rock.
C. J. Jennings & Co	Syracuse, N. Y	2 75	
George Kellogg	Fulton, N. Y	6 50	
N. G. Dodge & Co	Cleveland, Ohio	2 59	

D. 11.

REPORT UPON THE IMPROVEMENT OF CONNEAUT HARBOR, OHIO.

The end of the west pier, which had settled 5 feet after its construction, was in November leveled up to a height of 7 feet above the water, using for this purpose 12,000 feet, board measure, of timber and plank, 1,400 pounds of iron and spikes, 70 cords of stone. This work was done by days' labor.

An appropriation was made July 11, 1870, for $6,000 for the further improvement of the harbor. Sealed proposals were publicly invited to May 29, 1871, for the material and workmanship necessary in the extension of the east pier a distance of 90 feet, and a contract was made with Hugh W. Smith, of Buffalo, New York, June 17, 1871, at the several prices contained in the abstract of proposals accompanying this report. Work under this contract will commence in July.

Balance June 30, 1870	$2,864 15
Appropriated July 11, 1870	6,000 00
Total	8,864 15
Expended during the year	1,542 33
Balance June 30, 1871	7,321 82

No additional appropriation recommended. Amount probably required annually to keep piers in repair, $800.

Conneaut is in the collection district of Cuyahoga, Ohio, near Conneaut beacon-light.

Abstract of proposals for furnishing material and construction of piers at Conneaut Harbor, Ohio, opened at Buffalo, New York, May 29, 1871.

Name of bidder.	Residence.	CLASS I.—TIMBER.				CLASS II.—IRON.			CLASS III.—STONE.	CLASS IV.—LABOR.		Nature of work.
		Timber, pine, per thousand, board measure.	Timber, oak, per thousand, board measure.	Timber, hemlock, per thousand, board measure.	Piles driven in work, each.	Drift-bolts, per pound.	Wrought spikes, per pound.	Screw-bolts, per pound.	Stone placed in work, per cord.	Putting timber in place, per linear foot.	Laying plank, per thousand, board measure.	
J. S. Stearns	Conneaut, Ohio	$19 50	....	$18 00	$16 00	$0 04½	$0 05⅛	$0 07	$13 00	$0 12	$7 00	Constructing and putting in place 90 feet piering, as directed by the engineer in charge.
William Nicolls	Detroit, Mich	23 00	....	18 00	10 00	5	5	7	11 00	12	7 00	
Hugh W. Smith	Buffalo, N. Y	19 00	....	....	15 00	4	5	5	10 00	11	8 00	
A. A. Richards	Conneaut, Ohio	19 75	....	....	16 00	4½	5¾	8	13 25	13¾	8 00	
Hemmenway & Garfield	Painesville, Ohio	20 00	$45 00	....	15 00	5	5⅛	8	12 00	12	12 00	
Pratt & Co	Buffalo, N. Y	....	....	....	....	4¾	5⅜	7	....	....	....	
Smith & Barrington	Conneaut, Ohio	30 00	....	....	15 00	....	....	....	....	....	....	

D 12.

ANNUAL REPORT UPON THE IMPROVEMENT OF ERIE HARBOR, PENNSYLVANIA.

During the fiscal year 9,851 cubic yards of sand have been removed from the inner bar, and 15,466 cubic yards from the outer bar of this harbor, under the contract with Lee & Dunbar, of Erie, Pennsylvania, dated March 29, 1867.

The repairs to the breakwater connecting south pier with the south shore, unfinished at the close of the last fiscal year, were completed during the month of December.

An appropriation was made July 11, 1870, for $20,000, for the further improvement of this harbor, and has been used in part for the repairs to the breakwater.

An appropriation was made March 3, 1871, for $29,000, for the further improvement of the harbor. Sealed proposals were publicly invited to May 25, 1871, and a contract was made with Lee & Dunbar, of Erie, Pennsylvania, June 17, 1871, for removing 60,000 cubic yards of sand from the channel across the inner bar, at 23 cents per cubic yard.

Under the same appropriation, sealed proposals were publicly invited to May 29, 1871, for removing the sunken cribs near the east end of the north pier, and for the supply of the material and workmanship necessary in the extension of the north pier eastwardly 120 feet, and a contract was made June 17, 1871, with Hugh W. Smith, of Buffalo, New York, at the several prices for material, &c., given in the abstract of proposals accompanying this report. The channel across the inner and outer bars will be widened to 350 feet; the width between the piers at the beacon-light on north pier, and when completed, will have 15 feet of water at low stage.

An allotment of $10,000 has been made for the protection of the peninsula, and will be expended during the year in the purchase and planting of trees, and also in the construction at the threatened points of jettees of brush and stone.

Balance available June 30, 1870		$31,650 94
Appropriated July 11, 1870		20,000 00
Appropriated March 3, 1871		29,000 00
Allotted for peninsula		10,000 00
Total		90,650 94
Expended during the year	$29,420 53	
Due June 30, 1871	2,234 65	
		31, 655 18
Balance June 30, 1871		58,995 76

No further appropriation recommended. Amount probably required annually to keep piers and breakwater in repair, $1,500.

Erie is situated in the collection district of Erie, near Erie light, and is a port of entry.

All of which reports are respectfully submitted.

G. L. GILLESPIE,
Captain United States Engineers.

Abstract of proposals for removing old pier and pier construction at Erie Harbor, Pennsylvania, opened at Buffalo, New York, May 29, 1871.

Names of bidders.	Residence.	CLASS I.		CLASS II.			CLASS III.	CLASS IV.			REMOVING WRECKED PIER		Nature of work.
		Timber, pine, per thousand feet, board measure.	Timber, oak, per thousand feet, board measure.	Drift-bolts, per pound.	Wrought-iron spikes, per pound.	Screw-bolts, per pound.	Stone placed in work, per cord.	Piles driven, each.	Framing timber, per linear foot.	Fastening and putting plank in place, per thousand feet, board measure.	Dredge, per day.	For—	
Hugh U. Smith	Buffalo, N. Y	$19	....	$0 4	$0 5	$0 5	$10	$15	$0 11	$8	$100	....	Removing portion of wreck'd north pier.
Pratt & Co	do	....	....	4¼	5¼	6¾	....	....	....	....	....	....	
Hemmenway & Garfield	Painsville, Ohio	20	$45	4½	5	8	12	15	12	12	....	$6,000	Construction 120 feet piering.
James & John Dunlap	Erie, Pa	25	....	8	8	8	10	18	....	5	....	....	

The following remarks appear on Messrs. James & John Dunlap's proposal, viz: Framing above water, 10 cents per linear foot; framing below water, 14 cents per linear foot; removing wrecked pier, foreman $3 50 per day, laborers $2 50; crane-scows, each, $3 per day. Dredging at lowest cost price.

Respectfully submitted.

G. L. GILLESPIE, *Captain of Engineers, U. S. A.*

Abstract of proposals for improving Erie Harbor, Pennsylvania, opened at Buffalo, New York, May 25, 1871.

Names of bidders.	Residence.	Per yard.*	Per yard in bank.	Per yard in scows.	Detention of dredge for stress of weather, per day.	Description of work.
C. S. Jennings & Co.	Syracuse, N. Y.	$0 29				Removing from the channel over the inner bar 60,000 cubic y'rds, more or less, of sand and clay.
Lee & Dunbar	Erie, Pa	21			$25 00	
Lee & Dunbar	Erie, Pa		$0 23	$0 22		
Clark & Douglass	Buffalo, N. Y			33		

* No conditions specified as to measurement.

Respectfully submitted,

G. L. GILLESPIE,
Captain of Engineers, United States Army.

D 13.

UNITED STATES ENGINEER OFFICE,
Painesville, Ohio, October 1, 1870.

GENERAL: I transmit to you by express to-day a map showing the result of the survey of the head of the peninsula at Erie Harbor, Pennsylvania, made in obedience to your orders, and for the purpose of showing what changes if any have been recently effected in its shore lines, and especially such as might endanger the safety of the harbor by rendering probable the breaking through of the waters of the lake.

By reason of the constant employment of my two assistants in works of improvement which could not be deferred at the various harbors under my charge, it was not until near the close of June that I was able to start this survey.

The map and report of the superintending engineer, Colonel Irvin Camp, reached me about the latter end of August, and the pressure of office-work has prevented me from transmitting them earlier.

The only reliable map of Erie Harbor in my possession with which our survey could be compared was that of John De la Camp, made in 1865, under the direction of Brevet Colonel W. F. Raynolds, major of engineers, and superintendent of the survey of the north and northwestern lakes, and transmitted to the Bureaus of Engineers, February 24, 1866.

As in so delicate an operation as the comparison of two surveys carried over a distance of nearly four miles, in very nearly a right line, with few or no means of checking the accuracy of the observations, the extremest caution was necessary, I procured from Major C. B. Comstock, Corps of Engineers, in charge of the lake survey, the data necessary to enable us to recover the base-line made use of by De la Camp in his survey, and with this as a starting-line, (marked base-line No. 3 in the map of our survey,) the remaining bases were fixed with a transit, and the result is, I believe, as accurate as an instrumental survey can well be.

The map herewith gives in differently-colored lines the various horizontal curves of the surface surveyed as we found them, their planes being 3 feet apart, beginning at the water-line; and the same curves as shown by De la Camp's map are also plotted thereon in black.

It is to be observed, however, as stated in the legend on the map, that in the survey of 1865, the water stood at 5.325 feet; in the present survey at 4.700 feet, being readings of the water-gauge, near the beacon on the north pier, and indicating that the water at the time of our survey was .625 foot, or 7.5 inches *higher* than at the date of De la Camp's survey. In the map herewith, the water-mark, as found by us, has been reduced to the level of the water of De la Camp's survey (approximately) by assuming the slope of the lake-shore as being one upon six; *but no reduction has been made of the other horizontal curves*, which should be from 3 to 4 feet outside of their present positions. This, however, is of no great importance in the discussion of results.

What follows, however, is of greater importance in the discussion of those results, and should be carefully borne in mind while considering them. Assuming what I believe to be true, that the present survey made in relation to a special object is accurate, and that the map thereof is made with equal accuracy, it is plain that the whole value of our deductions must depend upon the accuracy of the shore-line, as shown by De la Camp's map. Now that map is a *lithograph*, 900 feet to the inch, reduced from the original, as drawn in the office of the lake survey; and to make it sufficiently distinct, when containing the curves found in our survey, we have had to enlarge it again to our own scale, which is 250 feet to the inch. An error of *one-thirtieth* of an inch, then, which might have crept into the lithographic copy, would make a difference of 30 feet in the position of the shore-line; and as De la Camp's map was constructed for general purposes, and probably (especially in the reduction) with little or no expectation that measurements of so diminutive a character would ever need to be made from it, it is quite within the limits of probability that such differences may have arisen. As the position of the shore-line, as found by us, varies from that found by De la Camp, from 30 feet to 100 feet, extreme, it will be seen that the preceding consideration is one of importance in forming a judgment as to a change of position in this shore-line.

The points which prominently appear, upon an examination of the map herewith, are these:

1st. The survey extends from the bluff on the main land over a narrow, sandy strip to the point on the shore-line of the peninsula, where the timbered region begins, a distance by base-lines of 19,454 feet= 3.68 miles.

2d. Up to the end of base-line No. 5, a distance of about 12,700 feet, or two-thirds of the whole, the two shore-lines continually cross each other—showing that the superficial area of the accretions is about equal to that of the encroachments. But in addition it is seen that over this whole distance a six-foot curve has been established, where no six-foot curve existed in 1865.

The apparent accretions and encroachments along this entire line so far, may well be referred to the variations due to change of scale in the map of 1866; but even supposing that they are real as well as apparent, the general average shows a decided gain for this portion of the peninsula.

3d. Base-lines 6, 8, 9, 10, 11, and 12, show an apparent retrogression of the shore-line (average about 60 feet) over a distance of 5,548 feet—a little over a mile—while base-line 7 shows a slight progression seaward. This brings us up to the heavily-wooded ridges which cover the remainder of the peninsula, beyond which our survey does not extend.

For more detailed statements of the condition of these shore-lines, see Colonel Camp's report, appended hereto.

Concerning that report, it is to be observed that he assumes two things: first, that all the lines of De la Camp's survey as plotted are absolutely correct; second, that all his averages in relation to apparent changes are referred to an interval of *four* years instead of *five* years, as they should be.

In conclusion I have to say that—

First. There is nothing in the condition of the peninsula that need occasion alarm to those interested in the preservation of Erie Harbor; for supposing the chart to indicate correctly the degree of erosion, its rate is such that no danger need be apprehended within the next two years, if ever.

Second. Supposing the waters of Lake Erie should at any future time break through into the brushy pond mentioned on page 8 of Colonel Camp's report herewith, or into Long Pond, as mentioned on pages 13 and 14 of same report, the result, so far from being an injury to the harbor, would in all probability be a conversion of these shallow pieces of water into dry land by the washing in of sand.

Third. A comparison of the map of this survey and De la Camp's map of 1865, with the only other map of this harbor which I have, viz, Anderson's map, made in 1819, shows that the condition of the peninsula is infinitely better now than it was then, being both broader and higher. Probably every part of this shore is, at different times, washed away, and rebuilt again; but in order to ascertain accurately what changes are annually taking place in its surveys such as this just completed should be annually made, so that if any injury to this fine harbor is really threatened, it may be known in time and properly guarded against.

For this reason I recommend that the sum of $1,500 be appropriated for the re-survey of the shore-lines of the peninsula in the spring, which survey, when compared with that which we have just completed, will furnish accurate and indisputable information as to the changes being effected.

If, after such survey, it be found necessary to protect the outer shore of the peninsula, such protection, I think, could be best afforded by heavily riprapping it, at a cost probably of $3 per linear foot, which would amount, taking the length of erosion from Colonel Camp's report, to about $25,000.

Very respectfully, your obedient servant,

WALTER McFARLAND,
Major of Engineers.

Major General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

ERIE, *August* 20, 1870.

DEAR SIR: Herewith I give you final report of the survey of "the head of the peninsula" which forms and protects the western portion of the harbor of Erie, Pennsylvania.

The results are shown by a detailed statement of the encroachments, accretions, and land curves along each base-line of the survey, commencing near the the main-land shore at the extreme west end of the peninsula.

Base-line No. 1.—Total length, 2,200 feet; "average accretion on the lake side, on the first 1,100 feet is 30 feet = annual accretion of 7½ feet." (This is an error. De la Camp's map of Erie Harbor, with which the present survey is compared, though transmitted to the Engineer Bureau February 24, 1866, was really surveyed during the summer and fall of 1865, and is therefore *five* years old instead of *four*, as assumed in the present report; and this error runs through all subsequent averages, which are all too large by one-fifth.—W. McF.)

Average encroachments for next 1,100 feet on lake side is 35 feet = annual encroachments of 8¾ feet, with bay-shore line and 3-foot land-curves corresponding to the above changes; but we have in compensation for this driving-in of the lake-shore line, the clear establishment of a 6-foot land-curve along the whole length of this base, which is not shown on the map of the survey of 1866. This is an important and encouraging fact in the record of the present survey.

Base-line No. 2.—Total length, 4,025¼ feet. There is shown on this line an average encroachment on the lake-shore line of 64 feet for its entire length = annual encroachment of 16 feet. But we find in compensation about an equal *accretion* on the bay-shore line, with the addition of the establishment of a 6-foot land-curve not shown on the map of 1866.

Base-line No. 3.—Total length, 5,054¼ feet. This line is the main base-line of John De la Camp's (civil engineer) survey of 1866, secured by a stone monument at each end marked E. H. S.

On this line we find an average accretion about equal to the encroachment shown on base-line No. 2, with the exception of 700 feet of encroachment a little east of the center, with an average width of 35 feet, which is compensated by a *large* accretion just east of it, and by the establishment and continuation along this base of the 6-foot land-curve, (noted along base-lines Nos. 1 and 2,) not shown in map of 1866.

The variation shown in the bay-shore line may be mostly due to the difference between the water-levels of 1866 and 1870, which (in places of very shallow water with very gentle slopes under it) might not be eliminated by an *average* allowance of 6 feet in distance on the bay offset-lines to bring the present shore-lines to the level of the water of 1866, which, per water-gauge at beacon-light pier, was 5,325, water of 1870 being 4,700 feet = 0.625 feet higher than water of 1866.

Base-line No. 4.—Length, 100 feet, is more properly a rectangular *offset* from the east end of base-line No. 3, connecting with the west end of base-line No. 5. We find on this line the 15-foot, 12-foot, 9-foot, and 6-foot land-curves shown on the map of 1866, but we find the *area* embraced within these lines at this place, as well as at the ridges shown on base-lines Nos. 10 and 11, to be much less than indicated on that map.

I can only account for this fact by supposing that the curves were not instrumentally traced at these points, or that smallness of scale required additional breadth for clear delineation of the lines on the lithographed map.

Base-line No. 5.—Total length, 1,277 feet. There is an average accretion on the lake-shore side of this line of about 25 feet in width with but slight corresponding changes in the land-curves, the bay-shore line remaining about the same as in 1866, except as modified, probably, by difference of water-levels of 1866 and 1870, as explained in description of base-line No. 3.

Base-line No. 6.—Total length, 1,576 feet. The survey shows a very startling encroachment along the whole length of this line. The lake-shore line has been driven inland about 100 feet for 700 feet in length, and an average of 50 feet on the next 600 feet. The present shore-line for 800 feet in length being about 50 feet inside of the 3-foot land-curve, as shown on the map of 1866, with no barrier but a slight 3-foot land-curve along the eastern one-third portion of its length, the 6-foot curve terminating abruptly at about two-thirds distance of its length.

Near the eastern end of this base the beach is now but 200 feet wide, where the map of 1866 shows a width of 500 feet, and the present distance between the lake and bay 3-foot land-curves is only about 80 feet where the map of 1866 shows about 400 feet. In reference to this last-mentioned change, it is evident from an inspection of the interior lines of the two surveys that a large portion of this change is due to the action of the bay waters.

We find the present bay-shore line has passed with a sharp sinus, not only across the 3-foot land-curve, but has pushed *through* the point of the 6-foot ridge, as shown on the map of 1866. This point may have been, and probably was, swept off by water from the lake, sweeping during some long and heavy gale over the crest of the 3-foot exterior land-curve, but the bay-shore line could never be found where it now is, without some violent action from an entirely different direction, viz, from the bay. I, therefore, conclude that this deep sinus has been made by the action of waves in the bay during strong southerly and eastern winds.

This portion of the "head of the peninsula" demands immediate attention, as there is now but a very slight barrier between the lake and bay water.

Base-line No. 7.—Length, 1,250 feet. On this line we find some little compensation for the great waste on base-line No. 6 in a slight increment to the lake-shore line, averaging 40 feet in width for about 600 feet in length, and in the establishment of a nearly continuous 6-foot land-curve not shown on the map of 1866.

Base-line No. 8.—Length, 872 feet. At a point about 250 feet west of the west end of this line commences another very serious encroachment of the lake, upon the outer shore of the peninsula, extending thence along the whole front of base-lines Nos. 8, 9, 10, and 11 for about 3,800 feet in length.

The 6-foot land-curve described as nearly established along base-line No. 7 terminates abruptly near the middle of this line, and at its eastern end there is a width of only 70 feet, and a slight 3-foot land-curve between the waters of the lake and of a bushy pond which reaches inland almost through to the bay, with only a sand beach 30 feet wide scarcely 3 feet above its waters. At station 500 + 15 on this base we come to the line of the tall, thick, and full grown timber, which *distinguishes* all of the peninsula east of this line from the lightly timbered and barren portions of the head west of it.

Base-line No. 9.—Length, 600 feet. Average encroachment of lake on this line about 50 feet in width, with corresponding change of 3-foot land-curve. There is no 6-foot land-curve behind this base-line, and its western end overlaps the head of the bushy pond, as noticed on the eastern end of base-line No. 8.

Base-line No. 10.—Length, 1,490 feet. On this base we encounter the greatest encroachment on the exterior line of the peninsula. Near its eastern end the shore-line has been driven in 110 feet, making the present shore-line between the 6 and 9 foot land-curve lines as delineated on the map of 1866. There are no 6-foot land-curves behind this base, except those of the ridge running directly inland from the shore.

Base-line No. 11.—Length, 710 feet. Greatest encroachment on this line is 110 feet; same as on base-line No. 10. Average encroachment since 1866 is 72½ feet.

Base-line No. 12.—Length, 300 feet. This line closes the survey, with a *slight* accretion since 1866, making the total length of the exterior shore-line surveyed 19,354¼ feet = three and two-thirds miles.

The following summary statement in figures shows up the length and breadth of the frightful waste which is now and for years past (even anterior to 1866) has been going on along the outer shore of the peninsula, covering the whole length of base-lines Nos. 6 to 11, both inclusive, with a frontage of 4,830 feet, leaving out base-line No. 7, on which there is a slight accretion as above noted.

SUMMARY STATEMENT.

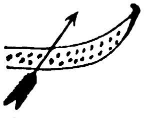
Base-line No. 6.—Length,	630	feet, by average width of 50 feet..........	31,500
Base-line No. 6.—Length,	780	feet, by average width of 100 feet.........	78,000
Base-line No. 8.—Length,	780	feet, by average width of 30 feet..........	23,400
Base-line No. 9.—Length,	600	feet, by average width of 40 feet..........	24,000
Base-line No. 10.—Length,	610	feet, by average width of 55 feet..........	33,550
Base-line No. 10.—Length,	720	feet, by average width of 70 feet..........	50,400
Base-line No. 11.—Length,	710	feet, by average width of 70 feet..........	49,700
	4,830		290,550

290,550 ÷ 4,830 = 60 ÷ 4 = 15, showing total *average* waste since 1866 along 4,830 feet of shore to be 60 feet in width, equal to a waste of 15 feet in width for each year *since* that date. As to what it was *prior* to that date, a comparison between the map of 1866 and those of an older date (now in your hands or of the War Department) will have to be made.

On July 30 I made a reconnaissance at the head of Long Pond in company with Messrs. M. R. Barr and Wilson King, members of a committee of the Marine Hospital of Pennsylvania, a corporation having a quasi ownership of the peninsula under a grant and charter from the State of Pennsylvania. In pursuance of your request I herewith give you the results thereof:

By row-boat, under the pilotage of J. D. Paasch, we gained access to this long and secluded stretch of water by working our way through two narrow, winding, and bushy passages from the waters of Big Pond, which last pond we entered from the bay through a short, narrow channel close to and east of Chrystal Point. We rowed our boat to near the head of Long Pond, and landing on the eastern shore, we skirted along the edge of a bushy marsh at the head of this pond for about a quarter of a mile to the lake shore opposite the head of this pond and marsh.

We found here, in uprooted timber of recent and former dates, and in ragged and indented shore-line, all the evidences of the same rapid waste on the shore-line as that noted in our survey, (along base-lines Nos. 6 to 11,) which, per scale of map of 1866, closed some 4,000 feet west of where we then stood, and in looking east it appeared to extend about 1,000 feet farther on, ending in a curved indentation fronting the west, thus:



On a more careful and extended survey around the marsh at the head of the pond, I found the shore driven in beyond the 6-foot land-curve line of the map of 1866, and found only a remnant of the inside slope thereof remaining, with a height in no place exceeding 3 to 4½ feet, and with only a width of from 30 to 60 feet, between the waters of the lake and marsh; into which last there were fresh traces of sand and some light drift-wood having been lately driven.

The importance of protecting this point *soon* is made evident by an inspection of the map of 1866, which shows only a feeble barrier between the south end of Long Pond and Presqu' Isle Bay.

It is a noticeable fact that, with the large abrasion which has been going on for so long a period along the exterior lines of this and adjacent portions of the peninsula, that there should be found hardly any compensating inland accretions, in the shape of new land-curves forming, or the heads of ponds and marshes filling up, and it suggests forcibly the inquiry, where has this vast quantity of material found a lodgement? The answer to this inquiry is readily found by an inspection of the map of 1866, which shows that the material has been swept along the shore eastwardly by the force of the prevailing westwardly winds till it passed the eastern and northern vertex of exterior curve of the peninsula, and there settled in the comparatively quiet waters lying under the lee thereof, and thus and there formed, the long and wide barren sand-beach so distinctly shown on that map.

The points of interest and of danger within the lines of this survey are found as stated below, with suggestions for the repair of each locality added.

First. At east end of base-line No. 6. Here, as before described, the distance between bay and lake-shore lines is now only 200 feet, and the distance between lake and bay 3 feet, land-curve lines has been recently reduced to 80 feet.

There is also shown on our map a break in the continuity of the 6-foot land-curve for about 1,000 feet in length, between about the centers of base-lines Nos. 6 and 7. I would fill this breach upon the general line of this curve with alternate layers of brush and logs, about 3½ or 4 feet high for, say, 15 or 20 feet in width, and cover the same with a light covering of the adjacent sand for temporary protection against fire. The sand taken for this purpose on the lake side would be soon replaced by sand occasionally thrown over the 3-foot land-curve, and the sand taken on the bay side would be soon replaced by the drifting sand settling down behind and under the lee of the barrier thus erected, and the accretions by wind and waves would soon establish a full and broad 6-foot land-curve, now wanting on this portion of the head of the peninsula.

On this base-line we also find a dangerous sinus in the bay shore-line. For this I would suggest the construction of a barrier about 750 feet in length, about 12 feet in width, constructed of brush and stone, on the line indicated on the map in pencil, to a height of one foot above the present stage of water. This would be a sufficient protection against any further deepening of the sinus, and the sand thrown over this barrier would be retained behind it and soon fill up the sinus, and thus the former shore-lines at this locality would be cheaply restored.

Second. At junction of base-lines 8 and 9 at this point, as described in place, there is only 70 feet in distance, and a light 3-foot land curve between the waters of the lake and a brushy pond, extending through very nearly to the bay. In front of this pond, along the lake-shore, there is a belt of fallen trees, 20 to 30 feet in width, with the roots to some of them yet attached, which have been undermined by the waves, lying at all conceivable angles with and upon each other. If the spaces between the trunks of the trees were first well filled with brush, properly disposed, and then well loaded with stone, I think this present imperfect barrier of fallen trees might thus be turned into a lasting and effective protection, not only at this point and the head of the Long Pond Marsh, but for the whole exterior line of the timbered portion of the peninsula.

Piling and cribbing were both unavailingly tried for closing a breach at the head of the peninsula about the year 1844, as I am informed, and the methods above suggested conform as near as practicable to the methods at that time successfully employed.

For the further strengthening of all that portion of the head which is west of station 500 + 15 of base-line No. 8, I would suggest the planting between the bay shore-line and the line of the 6-foot land curve, two rows of silver-poplar slips, 100 feet apart, with the slips 100 feet apart in each row, alternating them so that the slips of one row would stand mid-way of the spaces of the other row, thus:

These slips in a few years would become trees, and throw up shoots almost as thick as a clover field, and with their roots interlacing each other would cover and bind the whole area of the head together, and grow up there a splendid forest, where there is now (especially on the western half of it) only an arid and unsightly waste of drift-wood and sand.

IRVIN CAMP, *Civil Engineer.*

Major WALTER MCFARLAND,
United States Engineer Corps.

A true copy.

WALTER MCFARLAND,
Major of Engineers.

D 14.

Proceedings of a board of engineers convened at Erie, Pennsylvania, by virtue of the following order, viz:

[Special Orders No. 111.—Extract.]

HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., October 10, 1870.

1. A board, to consist of the following officers of the Corps of Engineers, viz: Lieutenant Colonel I. C. Woodruff, Lieutenant Colonel J. G. Foster, Major Walter McFarland, will assemble at Erie, Pennsylvania, on the 17th instant, or as soon thereafter as practicable, to examine and report upon the condition of the peninsula of Erie Harbor, especially the western portion of the same, and prepare such plans for its protection, with estimates of cost, as the preservation of the same may seem to require.

* * * * * * *

By command of Brigadier General Humphreys.

THOS. LINCOLN CASEY,
Major of Engineers.

ERIE, PENNSYLVANIA, *October* 18, 1870.

The board met at 10 a. m.—present, all the members—and organized for business by the reading of the following letter of instructions:

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., October 8, 1870.

COLONEL: In pursuance of Special Orders No. 111, headquarters Corps of Engineers, dated October 8, 1870, a board of engineers, of which you are the presiding officer, is to meet at Erie, Pennsylvania, on the 17th instant, to examine into the condition of the peninsula of Erie Harbor, (especially the western portion of it,) and report whether it needs any protection. If, in the judgment of the board, such protection is required, a plan, with estimate of cost, will be submitted.

Major McFarland has been instructed to lay before the board all maps, plans, and other information in his possession bearing upon the subject, comprising a report and map of a recent survey of the harbor, made under instructions from this office.

Should the board require any further information than he is able to afford, application should be made to this office.

By command of Brigadier General Humphreys.

Very respectfully,

JNO. G. PARKE,
Major of Engineers.

Lieutenant I. C. WOODRUFF,
Corps of Engineers, No. 16 *Broadway, New York City.*

Major McFarland then laid before the board the following maps and reports, viz:

1st. Anderson's map of Erie Harbor, Pennsylvania, 1819.

2d. Williams's sketch of United States works at head of Presqu' Isle Bay, accompanying annual report of 1838.

3d, De la Camp's map of Erie Harbor, Pennsylvania, made under direction of Brevet Colonel W. F. Raynolds, Major of Engineers, in 1865.

4th. Map of the survey of the head of the peninsula, Erie Harbor, Pennsylvania, made under direction of Major Walter McFarland, Corps of Engineers, in 1870.

5th. Report of Major Walter McFarland, Corps of Engineers, upon the survey of the head of the peninsula, Erie Harbor, Pennsylvania, made under his direction in 1870.

6th. Report of Colonel Irvin Camp, Corps of Engineers, who made the last-mentioned survey.

After discussion of the reports and comparison of the maps presented, the board proceeded, at 2½ p. m., to the head of the bay, and made a personal examination of the peninsula, from the oil well to the end of base-line No. 5, a distance of about two miles and a quarter, returning by the same route and reaching the city at 6 p. m., when they adjourned to meet the next day at 9½ a. m.

WEDNESDAY, *October* 19, 1870.

The board met at the time appointed, and resumed the consideration of the subject before them.

Commander George Brown, United States Navy, having kindly offered the use of his gig, the board at 10 a. m. started in it to resume their personal examination of the peninsula, landing on its bay side and examining every part of it from the point where the preceding day's examination terminated to the end of the base-line No. 12, the eastern limit of Major McFarland's survey.

At 2½ p. m. they proceeded in a steam-tug out of the harbor and along the lake side of the peninsula to a point opposite the eastern extremity of base-line No. 12, landed, and made a personal examination of the shore-line from that point to a point on the outer shore opposite the head of Long Pond, after which they returned to the city, and at 6 p. m. adjourned to meet the following day.

THURSDAY, *October* 20, 1870.

The board met at half past 9 a. m., and after consulting with Messrs. Noble, mayor of the city, Dobbins, King, and Arbuckle, old residents, as to their recollection of the condition of the peninsula in the past, the injuries which it had sustained from the waters of the lake, and the means taken to repair those injuries, proceeded at 2 o'clock p. m. again to the peninsula, and passing in small boats through Big Pond and Long Pond, landed and carefully examined the stretch of swamp and woodland which lies between the head of Long Pond and the lake, and after examining also the condition of the beach near the light-keeper's dwelling, at the north pier of the harbor, and the growth of the slips of silver-poplar which were set out here in April last, returned to the city, and at 6 p. m. adjourned to meet the next day.

FRIDAY, *October* 21, 1870.

The board met at 9 o'clock a. m., and agreed upon the following

REPORT.

From the investigations made by the board, and the information obtained from official records and other sources, it appears that systematic operations have been in progress under the direction of the Engineer Department, and large appropriations have from time to time, since the year 1834, been made by Congress, to the end of protecting the western extremity of the peninsula, and restoring the connection of the peninsula with the main land by what has been known as the "Neck." These operations of the United States have been successful, and the western extremity is now stronger than it has been since the break or crevasse through the Neck, which occurred somewhere about the year 1830, and remained open for the space of about twenty years, having been closed about the year 1854.

The expedient finally adopted for closing this crevasse was suggested by General Hartman Bache, of the engineers, and consisted in laying brush and loading it with stones, a process which has been applied in the course of the last few years, and has been successful in the protection of Provincetown Harbor, Massachusetts, under the direction of General J. G. Foster, lieutenant colonel of engineers.

The expedient for maintaining the continuity of the shore-line along the Neck and the peninsula is thus clearly indicated, and should not be lost sight of in any future operations that may be undertaken.

The board is of the opinion that the peninsula is in no immediate danger from the action of the lake waters, but that as a measure of precaution against possible damage in case of a succession of seasons of unusually high water, accompanied with severe storms, it would be well to re-enforce those points where the 6-foot curve no longer exists, viz., near the eastern end of base-line No. 6, and at the junction of base-lines 8 and 9; and as a further protection to this portion of the peninsula, the board think that the growth of vegetation upon it should be encouraged to as great an extent as possible, and for this purpose it is believed that slips of the silver-poplar or beach, which grows and multiplies its roots and suckers with great rapidity, should be used extensively, and most especially at those points where the vegetation is sparse.

To cover the entire barren portion of the Neck with these would cost not less than $5,000, and to introduce the brush and stone constructions above referred to, at the low points mentioned, would probably cost as much more, and it is recommended therefore that $10,000 be applied to these purposes.

The board is also of the opinion that a careful survey of the lake-shore of the peninsula should be made in the spring, and should be repeated annually for a series of years, in order to ascertain positively whether there is any law governing the changes which are perceptibly taking place in its contour, its rates of growth or waste, with a view to the establishment of some general system of protection, if necessary.

The board desire to call earnest attention to the danger which threatens this fine harbor from depredations or injurious changes made on the peninsula. This is now under control of the board of trustees of the marine hospital of Pennsylvania, with power to lease, improve, and administer generally for the benefit of said hospital, with no restriction of law as to operations which may endanger the safety of the peninsula.

Under this authority several houses have been built thereon, parts have been leased, timber has been removed, and it is now proposed to establish here a park and pleasure-grounds, which can only be done by clearing away trees and undergrowth necessary to the preservation of the peninsula, and, therefore, of the harbor.

The board, strongly convinced of the great danger of allowing any interference whatever with the vegetation of the peninsula, are unanimous in the opinion that the attention of the legislature of Pennsylvania should be called to this matter, in order that such enactments may be made as shall secure the safety of the harbor, and prevent the efforts which have been made by the General Government of the United States for its improvement under heavy annual expenditures from being counteracted.

These legal enactments should be made so as to insure the prevention of the removal of timber, either standing or fallen, brush, or drift-wood, from the peninsula or its shores.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
J. G. FOSTER,
Lieutenant Colonel of Engineers.
WALTER McFARLAND,
Major of Engineers.

There being no further business before it, the board adjourned *sine die.*

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
WALTER McFARLAND,
Major of Engineers, Recorder.

D. 15.—*Abstract of contracts entered into during the fiscal year ending June 30, 1871, for the improvement of harbors on Lake Erie, west of Dunkirk, New York.*

Contract.	Date.	Names and residence of contractors.	Name and residence of bondsmen.	Subject of contracts.	Name of officer by whom let.
	March 3, 1871	Andrew Spalding, Buffalo, N. Y.	Lewis J. Bennett, John Hand, Buffalo, N. Y.	Removing from main ship-channel through Maumee Bay, Toledo Harbor, Ohio, 120,000 cubic yards, more or less, of sand and clay.	Major W. McFarland, Corps of Engineers.
	March 4, 1871	O. J. Jennings, Syracuse, N. Y.	Thomas Keeler, George M. Case, Fulton, N. Y.	Removing from Sandusky Bay, Ohio, 25,000 cubic yards, more or less, of sand and river sediment.	
	March 7, 1871	Andrew Spalding, Buffalo, N. Y.	George Talbot, Lewis J. Bennett, Buffalo, N. Y.	Removing from the bar and channel, Cleveland Harbor, Ohio, 30,000 cubic yards, more or less, of material.	
A.	June 6, 1871	C. Fitzsimons, Chicago, Ill.	Seth N. Kimball, William B. Howard, Chicago, Ill.	Removing from the main ship-channel, through Maumee Bay, Toledo, Ohio, 200,000 cubic yards, more or less, of sand and clay.	Captain George L. Gillespie, Corps of Engineers, United States Army.
B.	June 17, 1871	Lee & Dunbar, Erie, Pa.	James H. Lee, Henry Montgomery, Buffalo, N. Y.	Removing from the channel, between the piers of entrance to harbor at Ashtabula, Ohio, 7,000 cubic yards, more or less, shale-rock.	
C.	June 17, 1871	Lee & Dunbar, Erie, Pa.	James H. Lee, Buffalo, N. Y.; Charles H. Lee, Silver Creek, N. Y.	Removing from the channel over the inner bar, Erie Harbor, Pennsylvania, 60,000 cubic yards, more or less, of sand.	
D.	June 17, 1871	Hugh W. Smith, Buffalo, N. Y.	Orville J. Jennings, Syracuse, N. Y.; Daniel E. Bailey, Buffalo, N. Y.	Constructing, furnishing material, and putting in place 90 feet piering, at Conneaut Harbor, Ohio.	
E.	June 17, 1871	Hugh W. Smith, Buffalo, N. Y.	Orville J. Jennings, Syracuse, N. Y.; Daniel E. Bailey, Buffalo, N. Y.	Removing portion of wrecked north pier; constructing, furnishing material, and putting in place 120 feet piering at Erie Harbor, Pennsylvania.	

Respectfully submitted.

G. L. GILLESPIE,
Captain of Engineers, United States Army.

D 16.

Report upon the survey of the harbor of Port Clinton, Ohio, made in accordance with letter of instructions from the Chief of Engineers, dated Washington, D. C., July 23, 1870.

The survey of this harbor was begun during the second week of November, and was continued at intervals, when the weather permitted, until near the close of that month, when the season became so cold and stormy as to prevent the soundings from being carried farther than the sketch indicates.

Enough was learned, however, of the character of the channel from the point where our labors terminated to its entrance into the lake, to enable us to form an estimate of the probable cost of attempting to improve it.

For a mile from the extremity of the peninsula, lying on the northern side of the river's mouth, the channel runs nearly parallel with the shore-line in an easterly direction, its only protection lakeward being a bar of shifting sand, through which it finally enters the lake. Through this channel, which is quite crooked, only about six feet water can be carried at the stage of water given by the survey.

If 8 feet depth could be given here the traders would be satisfied, for not more than 6 feet water can be carried down the Portage River from the lumber-mills above, which furnish the entire trade of this harbor.

A channel 8 feet deep and of sufficient width to accommodate the small vessels running here could be made at no very great expense; but it would be useless to do this, without at the same time constructing a breakwater for the whole length of the bar above mentioned, to preserve the channel so deepened from being filled in by the action of the lake waves upon its exposed flank. Such a breakwater properly built would cost not less than $250,000.

The only other alternative which presents itself, then, in order to make a good harbor here, is to break through this bar at some convenient point, and by the construction of an east and a west pier extending from the shore lakewards to the necessary depth, confine the waters of the river to the new opening, which would generally be kept open for the small vessels which alone make use of this harbor.

This suggestion has been made before by General Cram, and I agree with him in the location of the proposed cut, but not in the direction of the piers nor their mode of construction. By an examination of the sketch herewith, it will be seen that opposite the outer extremity of the 6-foot river-curve there seems to have been an effort made by the river-water to break through the bar. Here I would locate the new mouth, limited on the east by a pier running from 8 feet water nearly perpendicularly to the shore, and on the west by a pier starting at the same depth, and with two or three changes of direction, reaching the end of the peninsula at the mouth of the river.

This would require about 4,500 feet of piering, which, from its position, could near the shore-line, be built much lighter than a breakwater parallel with the shore, though at the outer ends the ordinary thickness of pier-work for these waters should be maintained.

The estimated cost of this I find to be $120,000.

The sketch herewith gives the proposed position of these piers.

I give below a statement of the amount of commerce of Port Clinton, for the eight months from April to December, 1869, since which time it has been steadily increasing:

Clearances: Steamers, 319; sailing-vessels, 274; total, 593. Tonnage, 32,800.

Average tonnage, 55. Average number of crew, between 4 and 5. Estimated value of cargoes, $332,000.

The number of entries is not included, because the trade is all outward.

One mile above the bridge the water shoals to 7 feet and continues so for three miles, then follows one mile of 8 feet water and eleven miles of 6 feet water, which carries us to the last mill on the navigable portion of the river. From Port Clinton to this point there are on the river bank six steam saw-mills, one large stave factory, and one shingle factory.

Respectfully submitted.

WALTER McFARLAND,
Major of Engineers.

D 17.

Report upon the survey of the mouth of Rocky River, Ohio, made in accordance with letter of instructions from the Chief of Engineers, dated Washington, D. C., July 23, 1870.

The survey of this river was limited to that portion of it lying below the bridge over which the main road from Cleveland to the West passes, as no part above the bridge could be rendered available for the purposes of commerce.

The survey was begun in the last week of October and was completed by the middle of November; although on account of the other duties required of my assistants, Irvin Camp, civil engineer, and David Enright, civil engineer, the plotting of the field-work was not begun until the last week in December.

The finished map was transmitted to the Chief of Engineers on the 20th of January, 1871.

By examining that map, an outline tracing of which accompanies this report, it will be seen that in its passage from the bridge to Lake Erie, a distance of about 1,000 yards, the river divides into branches, which, after encompassing an upper and a lower island, unite again and enter Lake Erie between a high rocky bluff on the west and a low sand-spit on the east.

The eastern branch varies between 150 and 250 feet in width, and the western branch from 75 to 100 feet in width.

The depth of water from the bridge to the head of the upper island, which on the sketch herewith is numbered 2, varies from 2 to 3 feet. Here, however, it begins to deepen slightly, and near the foot of island No. 2, 6 feet water is found. This depth, with four slight interruptions which are indicated on the sketch, is carried to the outer bar, where the water shoals again to nearly 4 feet.

Soundings were taken over this whole area, from the bridge to the 13-foot curve in the lake, at distances of 10 feet on lines averaging 100 feet apart, and borings to the rock substratum were also made at distances of 20 feet on lines averaging 200 feet apart. But one-half of these soundings and borings are plotted, every alternate one in each line having been omitted.

The results attained show that the bottom consists of sand chiefly, below which, at depths varying from 1 to 4 feet, rock is found.

The character of this substratum is probably not different from that of the rock forming the bluffs which border the river and the neighboring lake-shore, and which consists of thin strata of slaty material, so much broken with joints and fissures as to be easily separable. The fact that the auger frequently appeared to enter such joints seems to confirm this opinion; and I have been informed, furthermore, that this rock has been dredged out here and there, without the aid of blasting, to a depth of 8 or 10 feet. The material so moved which had been dumped along the shore of island No. 1, to prevent it from being washed away, I saw, and it appeared to be of the same character as that composing the bluffs.

To make this harbor available for commercial purposes, or as a harbor of refuge, two things are essential, viz: a very large amount of dredging, and the construction of an east pier, extending from the sand-spit at the mouth of the river to a point opposite the angle of the bluff on the west side.

At the stage of water given by the map, which may be taken as the *lowest* during the year, no vessel drawing over 4½ feet could cross the outer bar as at present. After passing this, although the water deepens to 10 feet in the channel off the spit, not more than 6 feet can be carried up the western branch to near the middle of island No. 1, while the passage into the eastern branch, which has about 6 feet water, is obstructed by a bar between the spit and the lower end of island No. 1, on which there is but little over 4 feet water.

My estimates I have limited to a channel-way 100 feet in width, extending from the outside of the outer bar through both branches to the head of island No. 1, and from 6 to 12 feet in depth; and I give the estimated cost of doing the work on both suppositions, *i. e.*, that blasting may not or may be required, reckoning the price of dredging sand at 30 cents per cubic yard; of dredging rock, without blasting, at 40 cents per cubic yard; of blasting, at $2 per cubic yard, and of dredging rock after blasting, at the same price as sand, *i. e.*, 30 cents per cubic yard.

Estimated cost without blasting.

To give a depth of—	Cubic yards.		Cost of—		Total.
	Sand.	Rock.	Sand.	Rock.	
Six feet	6,711	....	$2,013 30	....	$2,013 30
Eight feet	22,308	6,184	6,692 40	$2,473 60	9,166 00
Ten feet	53,600	23,250	16,080 00	9,300 00	25,380 00
Twelve feet	102,295	44,147	30,688 50	17,658 80	48,347 30

Estimated cost with blasting.

To give a depth of—	Cubic yards.		Cost of—		Total.
	Blasting.	Dredging.	Blasting.	Dredging.	
Eight feet	6,184	28,492	$12,368 00	$8,547 60	$20,915 60
Ten feet	23,250	76,850	46,500 00	23,055 00	69,555 00
Twelve feet	44,147	146,442	88,294 00	43,932 60	132,296 60

To make the eastern branch 200 feet broad and 12 feet deep would require from $15,000 to $50,000 additional, according as it did not or did require blasting.

The east pier proposed would be 500 feet long, and should be not less than 18 feet in width, which, at $60 per lineal foot, would require $30,000 for its construction.

The total amount, then, required to improve this harbor as herein explained would be—

To give a depth of—	Without blasting.	With blasting.
Six feet	$32, 013 30	
Eight feet	39, 166 00	$50, 915 60
Ten feet	55, 380 00	99, 555 00
Twelve feet	78, 347 30	162, 226 00
To which add, to give 200 feet width to the eastern branch	15, 000 00	50, 000 00
Total	93, 347 30	212, 226 60

The eastern branch might, however, be made 200 feet broad for the amount estimated as necessary in order to give a channel 100 feet broad up both branches.

Respectfully submitted.

WALTER McFARLAND,
Major of Engineers.

UNITED STATES ENGINEER OFFICE,
Painesville, Ohio, January 28, 1871.

APPENDIX E 1.

UNITED STATES ENGINEER OFFICE,
Buffalo, New York, September 10, 1871.

GENERAL: I have the honor to submit the following, my annual report, for the improvement of Dunkirk Harbor, for the fiscal year ending June 30, 1871:

The re-enforcement of the west United States pier mentioned in my last annual report was begun, and notwithstanding constant hinderance and loss inflicted by weather, was completed during the working season of 1869, and was the only work in hand during that season. The work now stands in good condition; the method of re-enforcement has proved a complete success. The work was done by hired labor by means of material remaining on hand from previous work.

The board of engineer officers convened at Dunkirk, New York, November 3, 1870, adopted a general plan for the further improvement of this harbor, which plan I was directed to carry into effect as far as the existing appropriation would avail. Preparations to this effect were made and work was commenced at the close of the fiscal year.

The removal of the old outer breakwater, after many unavoidable delays, was completed July 12, 1871.

Under the plan of the board of engineers the day-beacon will be built and about 200 feet of breakwater laid during the present working season, the work being done by contract with O. J. Jennings, of Syracuse, New York, under my letting of May 8, 1871, the iron material being purchased in open market, it having been found impracticable to contract for the same in time to complete the work this year.

The completion of the day-beacon and the section of the breakwater will exhaust the appropriation for this harbor, and further progress will depend upon the action of Congress as regards further appropriation.

Very respectfully, your obedient servant,

F. HARWOOD,
Captain Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
Washington, D. C.

E 2.

Proceedings of a board of officers of the Corps of Engineers, convened by virtue of the following order:

[Special Orders No. 117.—Extract.]

HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., October 28, 1870.

1. A board, to consist of the following officers of the Corps of Engineers, viz: Lieutenant Colonel I. C. Woodruff, Major Walter McFarland, Captain Franklin Harwood, will assemble at Dunkirk, New York, on the 3d of November, proximo, or as soon thereafter as practicable, for the purpose of preparing a plan, with estimates of cost, for the improvement of the harbor at that place.

* * * * * * *

By command of Brigadier General A. A. Humphreys:

THOS. LINCOLN CASEY,
Major of Engineers.

DUNKIRK, NEW YORK, *November* 3, 1870.

The board met in pursuance of the foregoing order. Present, all the members.

The board visited the harbor, and while there considered generally the subject of its improvement, referring, when necessary, to the plans and documents laid before them by the engineer officer in charge, as directed by the Chief of Engineers. After a general consideration and discussion of the subject, the board adjourned until 9.30 a. m., November 4, 1870.

The board met pursuant to adjournment. Present, all the members.

The board proceeded to a detailed examination of the subject of the improvement of Dunkirk Harbor, examining the records and considering the memoir of Captain F. Harwood, Corps of Engineers, dated January 22, 1869, and also his report of damages to the section of breakwater under construction by him during the year 1869.

In the light of these records the subject of a plan for the improvement of the harbor was held in discussion until the board adjourned to meet at 10 a. m., November 5, 1870.

The board met pursuant to adjournment. Present, all the members

The board proceeded to prepare a plan with estimates of cost for the improvement of Dunkirk Harbor.

Without arriving at a conclusion the board adjourned to meet 11 a. m. Monday, November 7, 1870.

The board met pursuant to adjournment. Present, all the members.

The board having duly studied the history of former improvements of Dunkirk Harbor, and the reports, plans, maps, and other information furnished it by the engineer in charge, having duly weighed the subject upon which it was called to deliberate, has the honor to submit the following

REPORT.

In view of the fact that portions of the harbor works at Dunkirk, owing to their peculiarly exposed location, have been repeatedly carried away, it is deemed prudent not only to give to any future work which may be constructed at that place a greater cross-section than has heretofore obtained, but also to take advantage of the partial protection afforded by the reef and the débris of old works in breaking the force of the wave by placing the new work farther to the south, and between the ruins of old works and the anchorage.

A line drawn from the eastern extremity of the breakwater proposed by the late Major Tardy, Corps of Engineers, and parallel with the western or longer portion of that work, and terminating westwardly at the 12-foot curve of the channel, would, in connection with the west pier already built, give all the shelter that the anchorage requires.

The old "dummy" or crib at the western end of the work of 1869, which marks the eastern limit of the channel at its entrance, should be repaired and preserved as a day-beacon. This and the end of the new breakwater just harborward from it will then furnish a permanent guide for vessels passing in or out of the harbor.

Whether it will be necessary to connect the new work with this old crib is a question which can only be determined by observation after the proposed work is begun. It is thought that the wreck of the old breakwaters may furnish a sufficient protection against waves coming from the north and east sufficiently heavy to be dangerous to vessels passing through the channel. Should this, however, prove not to be so, but that the proposed work should be connected with the old crib in order to protect the channel, this operation can be undertaken whenever the necessity above referred to may arise.

It is only intended in the sketch herewith furnished to indicate approximately the position which the work herein recommended should hold. Difficulties in the nature of obstacles on the bottom, large stones or pieces of old crib-work, may require the removal of the work to a short distance inside or outside of the line indicated on the sketch. This is a matter which should be left to the judgment of the engineer in charge of the work, to be by him determined after a minute examination of the site has been made.

However moved, it is not probable that the length will vary much from that indicated on the sketch, viz, 2,300 feet for the main portion and 560 feet for the branch adjacent, and parallel to the general direction of the channel. The construction of this shorter branch, as before stated, should be contingent on developments demonstrating its necessity.

The site herein suggested, while not contracting the anchorage, offers a securer place for the sinking of the cribs and increases the chance of being able to secure incomplete work before the sea can do it much injury.

The damage done to the section of breakwater last constructed was due to its being caught by a storm while in an incomplete condition, and it was torn to pieces little by little.

The board is of the opinion that the construction proposed by Captain F. Harwood, Corps of Engineers, in his memoir dated January 22, 1870, is well designed and adapted to its ends, and should be used in the work proposed by the board, if that work is ordered to be constructed. The board, however, considers that a height of 8 feet in superstructure over the local low-water level is necessary in this proposed work. A work constructed on Captain Harwood's plan, slightly modified to give 8 feet in height of superstructure, still preserving the slope of one upon two to the water surface, will cost about $100 per linear foot of pier, and will give about double the stability of the section destroyed last season.

The board indicates upon its sketch a channel of 13 feet depth, and 170 feet width, leading to the anchorage. Forty thousand dollars' worth of blasting and dredging will secure this, and the board is of opinion that, after the anchorage shall have been protected by the proposed breakwater, further appropriation may be expended to best advantage upon this channel, which, however, in its present state, answers all immediate needs of commerce. It is possible, but barely so, that an east pier may be necessary for the complete protection of the anchorage. A site is therefore indicated on the sketch, but the board considers the contingency so remote as not to render it necessary to incorporate this item in its estimates for proposed works.

The above-mentioned operations are all, the board considers, necessary for the improvement of this harbor at the present time, and they should be undertaken in the following order:

1st. Reconstruction of east or "dummy" crib as a day-beacon.

2d. Construction of breakwater.

3d. Blasting and dredging in channel to give 13 feet water for a width of 170 feet from present entrance to the anchorage.

4th. Construction of east pier if it shall become necessary.

With these conclusions the board has the honor to append the annexed sheet of estimates and sketch, showing the location of the improvements proposed.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
WALTER McFARLAND,
Major of Engineers.
F. HARWOOD,
Captain of Engineers.

Estimate of cost of improvements of the harbor of Dunkirk, New York, recommended by the board of engineer officers, convened November 3, 1870.

Reconstruction of east or "dummy" crib as a day-beacon	$5,000 00
2,300 feet of breakwater, at $100	230,000 00
560 feet of breakwater, at $100	56,000 00
Blasting and dredging for channel:	
17,413 cubic yards, at $2 02	$35,174 26
Contingencies, 12½ per cent	4,396 78
Total	39,571 04
Estimate	$40,000 00
Estimate for entire project	331,000 00

[Here is appended map of Dunkirk Harbor, New York, showing the improvements recommended by the board of engineer officers, November 3, 1870, and section at cross-wall breakwater at Dunkirk, New York, &c.]

E 3.

UNITED STATES ENGINEER OFFICE,
Buffalo, New York, September 10, 1871.

GENERAL: I have the honor to submit the following annual report on improvement of Buffalo Harbor, New York, and Buffalo sea-wall, for the fiscal year ending June 30, 1871:

The only work in progress during the year at this harbor has been the construction of the breakwater.

The following table exhibits the condition of the work during the fiscal year 1870-'71, and its probable progress made during the present working season:

State of work June 30, 1870.—Complete, 400 feet; incomplete, 950 feet.

Added during fiscal year 1870-'71.—In cribs, 750 feet; in superstructure, complete, 783 feet; incomplete, 265 feet.

State of work June 30, 1871.—Complete, 1,183 feet; incomplete, 1,711 feet.

Probable state of the work at close of working season, 1871.—Complete, 1,850 feet; incomplete, 2,064 feet.

The work has remained during the year in good condition excepting that, during the winter of 1870-'71, fields of moving ice inflicted slight damage, all of which will be repaired during the present working season at a trifling cost.

On the 28th of May, 1871, the propeller Eclipse, of the Erie Railway Company's line, ran into the head of the north United States pier, inflicting severe damage, which will be repaired and the pier-head secured, as far as possible, against a recurrence of like disaster during the present working season. To this end proposals have been advertised for and were opened August 17, 1871; and the work will be prosecuted and finished shortly. Work upon the breakwater has been prosecuted by contract, as follows: With D. E. Bailey, dated August 22, 1870; with D. E. Bailey, dated October 20, 1870; with D. E. Bailey, dated June 28, 1871, and will be continued under the appropriation of March 3, 1871, during the working season, under the last-mentioned contract.

The repair of the north pier-head will be completed before October 31, 1871, by contract with D. E. Bailey, dated August 29, 1871.

Very respectfully, your obedient servant,

F. HARWOOD,
Captain Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
Washington, D. C.

Report upon the Buffalo sea-wall for the fiscal year ending June 30, 1871.

The work remains as reported last year. No work has been done upon and none is proposed to be done until the necessity for it becomes apparent.

No funds have been expended during the fiscal year; none were ava able July 1, 1871, and none are desired for the fiscal year ending June 30, 1873.

F. HARWOOD,
Captain Engineers.

E 4.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., March 21, 1871.

SIR: The report of the board of engineer officers upon the bridge to be built across the Niagara River at Buffalo by the "International Bridge Company," submitted with my letter of February 18, 1871, has, as I have been informed by the Hon. Mr. Dawes, of the House of Representatives, been mislaid in one of the committee-rooms in the Capitol. In this report certain modifications in the plan of the bridge were proposed, and in order that the bridge company might conform to all these modifications, additional legislation seemed to be necessary, and a draft of an act or resolution was submitted and recommended for the favorable consideration of Congress.

Since no action was had by Congress at the last session, and as it appears to be probable that none will be had during the present session; and as the additional legislation asked for is not to affect in any way the main portion of the bridge, (that over the river proper,) but merely to authorize the substitution of a draw of 90 feet in Black Rock Harbor in the place of one of 160 feet, it is suggested that the bridge company be apprised of the decision of the Secretary of War in the premises, so that they may take such steps as they may think proper, having in view the fact that the report and modifications recommended by the board have been approved by the Secretary of War.

With these facts before them, it will be for the Bridge Company to determine whether they will continue the work in accordance with the approved modifications, and trust to securing the necessary legislation or await the action of Congress.

I inclose a copy of my letter of February 18, and also a copy of the report of the board.

Some engineer officer who is stationed at Buffalo, or on the lakes, should inspect the bridge when necessary.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP, *Secretary of War.*

Approved by the Secretary of War. The Chief of Engineers will send the requisite papers, &c., to the bridge company.

ED. SCHRIVER, *Inspector General.*

WASHINGTON, D. C., *February* 7, 1871.

GENERAL: I have the honor to transmit herewith the report of the board of engineers on the international bridge across the Niagara River, near Buffalo, New York, accompanied by the three original maps and profiles of the bridge sent to the War Department by the bridge company. We have indicated in red ink on the largest one of these sheets, which contains a plan and profile of the proposed bridge, the modifications we recommend. We will have prepared a small general map and profile, combining all the information we have obtained, as soon as practicable, to form part of the records of the Department. We accompany this report also by other papers referred to in the body of it—seven in number—marked from A to G, inclusive.

Yours, respectfully,

G. K. WARREN,
Major of Engineers and Brevet Major General, President of the Board.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

Report of the board of engineers convened by Special Orders No. 106, dated Headquarters Corps of Engineers, Washington, D. C., September 29, 1870, and ordered to examine and report upon the plan and location of a bridge to be erected across the Niagara River, at Buffalo, New York.

WASHINGTON, D. C., *February* 7, 1871.

GENERAL: The board of engineers, constituted by Special Orders No. 106, dated Headquarters Corps of Engineers, September 29, 1870, (copy appended and marked A,) met at Buffalo, New York, October 3, 1870, and in obedience to that order proceeded to examine the plan and location of the international bridge in process of construction over the Niagara River, at Buffalo. The board having first examined the plans and papers furnished from the office of Chief of Engineers for its consideration, then proceeded to visit the bridge site in order to examine the piers in process of construction, and procure from the bridge company's officers the data necessary to enable it to make a full and complete report upon the subject.

All the information available at the time having been collected, it was found that it was insufficient; inasmuch as no observations had been made for the force and direction of the current at the bridge site, neither was the survey of Black Rock Harbor sufficiently extended and in detail to determine the proper position and dimensions of the draw at that harbor.

The law of the State of New York prescribes that the bridge shall "not materially impede the navigation;" "shall be constructed in two draws, one across Black Rock Harbor, and the other across the main channel of the river;" and that "the draws of said bridge shall be of ample width to give free and unobstructed passage to all steamboats and other vessels navigating said river or Lake Erie."

The law of the United States further provides "that such bridge shall have at least two draws of not less than 160 feet in width in the clear between the piers, which shall be located at the points best calculated to accommodate the commerce of said river, and the piers of said bridge shall be parallel to the current of said river."

The plan of the bridge company proposed a bridge of nine spans from the Canada shore to Squaw Island, and four spans across Black Rock Harbor. Of the river spans the three nearest the Canada shore and the two nearest Squaw Island were to be 190 feet in the clear; the two adjoining the draw, of 240 feet each; and the draw-bridge, located nearly at the middle of the river, to be 354 feet long, swinging on a pivot-pier of 34 feet diameter, giving two clear passage-ways of 160 feet each.

The crossing of Black Rock Harbor was to be effected from Squaw Island, by first a draw-bridge of 184 feet, swinging on a pivot-pier of 34 feet diameter, giving two clear passage-ways of 75 feet each, then a span of 100 feet in the clear, then a span of 140 feet in the clear, reaching the abutment at the Black Rock shore. The dimensions of piers and specifications for the work are fully set forth in the MS. then before the board, and now herewith appended, and marked B.

In the light of the information then before the board, and their cursory examination of the bridge site, it appeared advisable to transfer the river draw from the location proposed by the bridge company to a point nearer Squaw Island, placing the pivot-pier in 16-feet soundings, the shore end of the draw resting on an abutment built out from Squaw Island. It also appeared to the board that the Black Rock Harbor draw might be made of smaller span than required by the United States law, and still answer all the requirements of commerce, if the law could be so modified. It was observed that the bridge company's plan gave only 75 feet in the clear to each opening of the Black Rock Harbor draw, which did not satisfy the conditions of the law. As that harbor was under the jurisdiction of the New York canal commissioners, it became necessary to consult their wishes on the subject. In view, therefore, of these facts, and the lack of necessary information, the board resolved to adjourn temporarily, delegating to the junior member the duty of obtaining from the bridge company's officers the additional data necessary to enable it to come to a decision, and also directing him to request of the canal authorities of the State of New York a map of Black Rock Harbor showing the changes they proposed to make in that harbor, and the location and width of such a draw as would be in accord with their plans.

The board thus adjourning temporarily, submitted a preliminary report to the Chief of Engineers, a copy of which is herewith appended and marked C.

The duty delegated to the junior member was performed. Observations for force and direction of the current were made by the bridge company's officers, using weighted floats 12 feet in length, and the result platted for the use of the board.

A plan of Black Rock Harbor was also prepared and submitted by the bridge company's officers, and in answer to the inquiries made by the board, New York State Canal Commissioner John D. Fay sent the reply, (appended and marked D.) accompanied by a map of the harbor showing the bridge-crossing, together with improvements projected by the canal authorities. The information thus collected was laid before the board reconvened at Washington, D. C., January 28, 1871, in obedience to Special Orders No. 7, dated headquarters Corps of Engineers, Washington, D. C., January 17, 1871, a copy of which is herewith appended and marked E.

The board first took up the question of the Black Rock Harbor crossing, considering the letter of Canal Commissioner Fay, dated November 9, 1870, and the accompanying map. In reply to this letter the board suggested in a letter to him that, for a draw-bridge over Black Rock Harbor, openings of 160 feet might be unnecessarily large, gave their reasons for this conclusion, and asked if the canal authorities of the State of New York would consent to a draw of less width, and if so, what width, and also suggested that the proposed new lock might be located to better advantage further up the harbor, about five hundred yards above the proposed bridge site.

In reply to this letter an answer (appended and marked F) was received, announcing 90 feet in the clear for each draw opening at Black Rock Harbor, as agreed upon by both the canal authorities and the bridge company, and that the proposed lock could be located to suit the circumstances of the case.

Having all the necessary data before it, the board proceeded to a careful consideration of the plan and location of the bridge, taking up first the subject of the portion crossing the river.

The board approves of the location of the bridge and its general plan, but respectfully recommends certain modifications in that plan which it will now proceed to discuss.

It appears by computation from the data furnished by the bridge company's officers that on the day when they observed the force and direction of the current the area of the natural section of the river at the bridge site was 41,106 square feet, the discharge per second at that time 245,296⅛ cubic feet of water, at an average velocity of 5.96 feet per second. By comparison of the bridge company's plan with the same modified by locating the river draw near Squaw Island, as proposed by the board, it was found that the piers as located by the bridge company obstructed an area of 3,815¾ square feet, kept back per second 25,258½ cubic feet of water, and would increase the average velocity of the current to 6.5 feet per second, whereas the piers and abutment, as located by the board, would obstruct an area of 3,497 square feet, keep back per second 19,069¼ cubic feet of water, and would increase the average velocity of the current to 6.37 feet per second. Thus it appears that there would be an increase of the mean velocity of the current by .54 feet per second by the bridge company's plan, while there would be an increase of only .41 feet per second by the same modified as proposed by the board.

It was also found by computation from the same data, that were the draw located as proposed by the bridge company in the axis of the river, the current at that draw would run six miles an hour as against four miles an hour through the draw located as proposed by the board. It is therefore obvious that if the wants of commerce can be subserved by locating the draw near Squaw Island, as proposed by the board, it should be done, inasmuch as thereby the flow of water will be least obstructed; the mean velocity of the current the least increased by pier obstruction, and the velocity through the draw-spaces greatly diminished, thus affording greater facility for the passage of vessels. It appears to the board that the wants of commerce will best be subserved by this change, inasmuch as the draw, as located by the board in the lesser current, will accommodate vessels of the greatest draught at present navigating the great lakes. The location for the draw proposed by the board is indicated in red on the profile upon the bridge company's plan, as also the modifications in the position of the piers, and the extent of the abutments to be built out from Squaw Island to receive the shore end of the draw-bridge. The depth of water in the in-shore draw-space varies from 8 to 16 feet, and would accommodate vessels of light draught at any stage of water. The depth of water in the outer draw-space varies from 16 to 25 feet, and would accommodate vessels of the greatest draught at all stages of the river.

The Squaw Island abutment, built out about 150 feet into the river, would serve as a guide for vessels passing the draw, thereby facilitating their progress, and also definitely mark the wharf line, should the shore of Squaw Island be used for such purposes. In recommending this change of position of the draw, the board desires it to be distinctly understood that the draw-spaces should remain unchanged from the original plan, leaving two clear passage-ways of 160 feet each in width, and the piers retain the same dimensions as before proposed, varying only in height to suit the depth of water. The modification in the arrangement of the piers and draw of the river branch of the bridge, as described above, and indicated on the bridge company's plan in red, is respectfully recommended as a substitute for the arrangement proposed by the company; and it may also be observed in this connection, that in conversation with the bridge company's officers the board have been led to understand that far from making any objection to the proposed change they gladly concur therein.

The saving in cost of construction is obvious upon comparing the two projects, to say nothing of the difficulty of building the pivot-pier as proposed by the company in 41 feet of water running at the rate of six miles an hour.

As regards the crossing of Black Rock Harbor, it is proper to consider the conditions to be satisfied in locating a draw at that point.

It appears from observation of the site that at the present time the harbor and canal are there without division; that a portion of the water of the canal and harbor is used to feed mills just below the bridge site; that the result of the lack of division between the harbor and canal is that the deposit of silt in the harbor is encroaching upon the limits of the canal. It also appears from Canal Commissioner Fay's letters and map, that the New York canal authorities propose to remedy the above-mentioned evil by building a division wall between harbor and canal, affording access from the one to the other by means of a ship-lock to be placed at some point in the division wall. Vessels, therefore, ascending the river, and desiring to avoid the swift current between the bridge site and the river's head, can pass through the old ship-lock as heretofore, thence through the new lock into the lesser current of the canal and harbor, and thence to Lake Erie. In order to do this with convenience and safety, the draw-bridge over Black Rock Harbor must be of such dimensions and so placed with regard to the two locks as to admit of vessels passing without great deviation from a straight course.

The letter of Canal Commissioner Fay, dated January 30, 1871, shows the agreement to which the canal and bridge authorities have come.

Inasmuch as the old lock will not accommodate vessels of greater beam than thirty-six feet, the board regards the draw, with openings of 90 feet each in the clear, as agreed upon by the canal and bridge authorities, as sufficient to satisfy the wants of commerce in the harbor, provided the new lock is properly located with reference to the bridge.

A larger opening is unnecessary, and rather liable to impede than facilitate the navigation and transit over the bridge, by the time lost in opening and closing. In order to have this location in harmony with the plans of the New York canal commissioners, the board recommends the Secretary of War to adopt such location of this draw as the New York canal commissioners may advise.

The recommendation of the board with regard to the modifications to the bridge in the main river are in accordance with the laws of the United States, and will require nothing but the approval of the Secretary of War.

In the opinion of the board, the width of openings in the draw at Black Rock Harbor are required by the United States laws to be 160 feet wide. The plan proposed by the bridge company allows of openings of only 75 feet, and the board has, on consultation with the New York canal commissioners, as beforesaid, recommended that they be made 90 feet wide. The board, therefore, suggests the following amendment to the existing law:

"*Be it enacted*, That the bridge across the Niagara River, near Buffalo, New York, authorized by the act approved June 30, 1870, shall be constructed with a pivot draw in the main river, giving two clear openings of 160 feet each, and across Black Rock Harbor, with a pivot draw, giving two clear openings of 90 feet each, subject, in all other respects, to the provisions contained in the act approved June 30, 1870."

With these conclusions the board respectfully submits the accompanying papers and plans, which have been under discussion before it during its deliberations, and will, at a future date, as soon as it can be prepared, submit, for the files of the office of the Chief of Engineers, a map embodying as much as possible of the information concerning the bridge, its site, and the river above and below the site, upon the basis of which the board has arrived at the conclusions herewith submitted.

We are, general, very respectfully, your obedient servants,

G. K. WARREN,
Major of Engineers and Brevet Major General, U. S. A.
WM. E. MERRILL,
Major of Engineers and Brevet Colonel, U. S. A.
F. HARWOOD,
Captain of Engineers.

Brigadier General HUMPHREYS,
Chief of Engineers, U. S. A.

APPENDIX F 1.

Annual report of Major J. H. Wilson, Corps of Engineers, for the fiscal year ending June 30, 1871.

REPORT OF OPERATIONS AT OLCOTT HARBOR, NEW YORK.

The opening of the year found the work in the following condition:

The east pier was 438 feet long, and 20 wide, 349 feet being built to its full height, and the remainder incomplete.

The west pier was 518 feet long, 305½ feet being 15 feet wide, and the remainder 20 feet wide; of this pier 501 feet was built to the full height, the rest being incomplete.

During the year there have been added to the east pier five cribs, each 30 feet long by 20 feet wide, and averaging 9½ feet in depth. The superstructure has been extended and filled with stone for a length of 170 feet. The east pier is now 588 feet long.

There have been added to the west pier six cribs, each 30 feet long by 20 feet wide, averaging 10½ feet in depth. The superstructure has been extended and filled with stone, for a length of 77 feet. The west pier is now 690 feet long.

During the winter 159,000 feet, board measure, of timber and plank, and 188 cords of stone, were purchased for work this season.

During the last season operations were carried on by hired labor, and the purchase of materials in the open market.

On the 12th of April, 1871, proposals were invited for labor and materials for this season's work, and on the 12th of May the contract was awarded Mr. J. D. Cooper, of Olcott. He commenced operations on June 5, and by the close of the fiscal year had succeeded in sinking three cribs, and completing the superstructure upon 200 lineal feet of the pier. The work is being pushed forward energetically.

During the present season, in addition to the work already completed, it is proposed to extend the east pier 140 feet, and the west pier 90 feet.

To complete the project for the improvement of this harbor will require that the piers shall be extended until a depth of 12 feet is reached in the lake, and that a channel 150 feet wide between the piers, and 200 feet wide from the inner end of the piers to the bridge, shall be dredged. This will require the extension of each pier 180 feet in addition to the extension to be built this season, and the removal of about 57,000 cubic yards of material.

The amount required to complete the work will be $35,000.

Olcott is a port of entry in collection district of Niagara.

The nearest fort is Niagara, eighteen miles to the westward, and the nearest light is at the fort.

The amount of revenue collected during the fiscal year was $44 80 in currency, and $1,138 65 in gold.

The number of vessels entering and clearing was 32, with an aggregate tonnage of 1,042 tons. Amount expended during the year, $9,966 50; amount available July 1, 1871, $5,501 28; amount required for the fiscal year ending June 30, 1871, $35,000.

Abstract of proposals for material and labor for pier-work at Olcott Harbor, New York. Opened by Major John M. Wilson, Corps of Engineers, United States Army, May 12, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—LABOR.									CLASS II.—STONE.					Grand total.
			Counter-hewing 10,000 ft. board measure.		Labor on timber 300,000 ft. board measure.		Labor and iron, 20,000 pounds.		Labor on treenails, 1,600 treenails.		Total.	Handling stone belonging to United States, 150 cords.		Furnishing stone, 325 cords.		Total.	
			Per foot.	Amount.	Per foot.	Amount.	Per pound.	Amount.	Per 100.	Amount.		Per cord.	Amount.	Per cord.	Amount.		
			cts.				*cts.*										
1	R. N. Gere	Syracuse, N. Y.	2½	$250 00	$6 50	$1, 950 00	¾	$150 00	$7 00	$112 00	$2, 462	$2 00	$300 00	$7 00	$2, 275 00	$2, 575 00	$5, 037 00
2	Henry J. Mowry	Syracuse, N. Y.	3	300 00	5 50	1, 650 00	½	100 00	8 00	128 00	2, 178	2 00	300 00	6 50	2, 112 50	2, 412 50	4, 590 50
3	*J. D. Cooper	Olcott, N. Y.	1½	150 00	6 00	1, 800 00	1	200 00	3 00	48 00	2, 198	1 50	225 00	6 00	1, 950 00	2, 175 00	4, 373 00
4	E. H. French	Fulton, N. Y.	3	300 00	7 00	2, 100 00	2	400 00	5 00	80 00	2, 880	2 50	375 00	5 50	1. 787 50	2, 162 50	5, 042 50
5	†Harvey E. Mathews	Olcott, N. Y.	......	....	......	....	......	....	......	....	....	......	....	......	....	....	....

* Awarded.

† Informed as to manner of bidding and form of guarantee. Items not specified on abstract, the informalities being such as would require special classification.

OSWEGO, NEW YORK, *May* 12, 1871.

Abstract of bids received and opened September 27, 1870, by Nicholas Bowen, major of engineers, for the delivery of stone for crib-filling at harbor of Olcott, New York.

Number.	Names of bidders.	Residence.	Stone, per cord.	
			On the shore.	In the pier.
1	* O. J. Jennings	Syracuse, N. Y.	$5 90	$6 45
2	* Charles J. DeGraw	Fulton, N. Y.	9 00	11 00
3	† Edward Short	Niagara, C. W		7 00

* Rejected for informality. No witnesses to signatures or guarantors.
† Rejected for informality. No witnesses to signatures or guarantors. See bid for Big Sodus.

OSWEGO, NEW YORK, *September* 27, 1870.

Abstract of contracts for each class of materials and labor for Olcott Harbor, New York during the fiscal year ending June 30, 1871.

Number.	Names of contractors.	Residence.	Date of contract.	CLASS I.—STONE.		CLASS II.—LABOR.			
				Handling stone belonging to United States, price per cord.	Furnishing stone, price per cord.	Counter-hewing timber, price per linear foot.	Timber work, price per 1,000 feet, (board measure.)	Iron work, price per pound.	Driving treenails, per 100.
1	J. D. Cooper	Olcott, New York	May 22, 1871	$1 50	$6 00				
2	J. D. Cooper	Olcott, New York	May 22, 1871			$0 1½	$6 00	$0 1	$3 00

OSWEGO, NEW YORK, *June* 30, 1871.

Abstract of contracts for improvement of Olcott Harbor, New York, during the fiscal year ending June 30, 1871.

No.	Names of contractors.	Residence.	Date of contracts.	Subject of contract.
1	J. D. Cooper	Olcott, New York	May 22, 1871	Stone.
2	J. D. Cooper	Olcott, New York	May 22, 1871	Labor.

OSWEGO, NEW YORK, *June* 30, 1871.

F 2.

REPORT OF OPERATIONS AT OAK ORCHARD HARBOR, NEW YORK.

The opening of the fiscal year found operations in progress at this harbor, the work being carried on by hired labor and the purchase of materials in the open market. During the summer and fall of 1870 five cribs, with superstructure, were added to the east pier, and four to the west pier, their total length being 270 feet; 150 feet of the superstructure near the middle of the west pier, and the same amount on the east pier, was renewed.

In September, 1870, proposals were asked for stone for crib filling, but were all rejected for informality. Work for the season was closed November 30, 1870.

During the winter 421 cords of stone were purchased at the rate of $4 per cord, delivered on the banks of the creek near the piers; 33,289 feet of pine plank was also purchased.

In April, 1871, proposals were invited for iron, stone, and labor for the piers, and for dredging a channel between them. On May 12 the pier-work was awarded to Mr. H. J. Mowry, of Syracuse, and the dredging to Mr. E. H. French, of Fulton.

Operations for this season were renewed June 12, 1871, and by the close of the fiscal year two more cribs were placed in position and sunk, and the superstructure completed on 40 lineal feet of the west pier.

During the present working season it is proposed to carry out the piers to the full extent of the project, by adding six cribs, 180 feet, to the west pier, and five cribs, 150 feet, to the east pier. This will carry them out to a depth of 12 feet at ordinary low water. It is also proposed to dredge a channel between the piers 150 feet wide and 12 feet deep at mean low water.

Amount available July 11, 1870	$16,733 91
Expended during year	10,998 36
	5,734 55
Amount appropriated for the fiscal year ending June 30, 1872,	10,000 00
Amount available July 1, 1871	15,734 55
Amount required for fiscal year ending June 30, 1873, for repairs	2,500 00

Oak Orchard is a port of entry in the collection district of Genesee. The nearest fort is Niagara, forty-five miles distant.

A fixed white light of the fourth order has been placed on the west pier during the present season.

The amount of revenue collected during the fiscal year was $1,800 in gold and $205 in currency. The value of the imports was $10,000.

Thirty vessels entered and 31 cleared during the year—the aggregate tonnage in each case being 3,000 tons.

Abstract of proposals for pier-work and dredging at Oak Orchard Harbor, New York, opened by Major John M. Wilson, Corps of Engineers, United States Army, May 12, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—IRON. Screw and washer bolts, 3,000 lbs. Per lb.	Am't.	Drift-bolts, 12,000 lbs. Per lb.	Am't.	Spikes, 1,400 lbs. Per lb.	Am't.	Amount total.	CLASS II.—STONE. Furnishing stone, 280 cords. Pr. cord.	Amount.	Handling stone, 420 cords. Pr. cord.	Amount.	Amount, total.
1	Moore & Harrington	Albion, N. Y	$0 06¾	$202 50	$0 05½	$660 00			‡Incomp'te	$6 47	$1,811 60	$3 00	$1,260 00	$3,071 60
2	H. C. Murray	Oak Orchard, N. Y	07⅛	213 75	07⅛	855 00	$0 7⅛	$99 75	$1,168 50	5 00	1,400 00	2 00	840 00	2,240 00
3	R. N. Gere	Syracuse, N. Y	06¾	202 50	04¼	510 00	06¼	87 50	800 00	7 00	1,960 00	2 00	840 00	2,800 00
4	E. R. Seward	Albany, N. Y												
5	William A. Wheeler	New York, N. Y	08½	255 00	5.95	714 00	07½	105 00	1,074 00					
6	Edgar M. Payne	Albany, N. Y												
7	Samuel G. Hart	Fulton, N. Y	06	180 00	06	720 00	06	84 00	984 00	10 00	2,800 00	2 00	840 00	3,640 00
8	C. P. Morse & Co	Oswego, N. Y												
9*	Henry J. Mowry	Syracuse, N. Y	06½	195 00	04⅛	495 00	06⅛	85 75	775 75	6 50	1,820 00	1 80	756 00	2,576 00
10†	E. H. French	Fulton, N. Y												
11	E. H. French	Fulton, N. Y	06	180 00	06	720 00	07	98 00	998 00	5 00	1,540 00	2 00	840 00	2,380 00

Number.	Names of bidders.	Residence.	CLASS III.—LABOR. Towing and sinking five cribs. Pr. crib.	Am't.	Counter-hewing 10,000 sup. feet. Pr. ft.	Am't.	Timber-work, 235,000 feet, board measure. Pr. 1,000 ft., b. m.	Amount.	Iron-work, 16,000 lbs. Pr. lb.	A'mt.	Drivingtree-nails 1,200. Per 100.	Am't.	Amount, total.	Grand total.	CLASS IV.—DREDGING. 30,000 cub. yds. Pr. cub. yard.	Am't.
1	Moore & Harrington	Albion, N. N.	$25 00	$125	$0 02	$200	$8 00	$1,880 00	$0 01	$160	$10	$120	$2,485 00	‡Incomp'te		
2	H. C. Murray	Oak Orchard, N. Y	30 00	150	03	300	10 00	2,350 00	01	160	12	144	3,104 00	$6,512 50		
3	R. N. Gere	Syracuse, N. Y	40 00	200	02½	250	6 50	1,527 50	00¾	120	7	84	2,181 50	5,781 50	$0 50	$15,000
4	E. R. Seward	Albany, N. Y													21½	6,450
5	William A. Wheeler	New York, N. Y												‡Incomp'te		
6	Edgar M. Payne	Albany, N. Y													40	12,000
7	Samuel G. Hart	Fulton, N. Y	50 00	250	05	500	8 00	1,880 00	01	160	5	60	2,850 00	7,474 00		
8	C. P. Morse & Co	Oswego, N. Y													45	13,500
9*	Henry J. Mowry	Syracuse, N. Y	50 00	250	03	300	5 50	1,292 50	00½	80	8	96	2,018 50	5,370 23	27	8,100
10†	E. H. French	Fulton, N. Y													17¾	5,325
11	E. H. French	Fulton, N. Y	25 00	125	03	300	7 00	1,645 00	01	160	5	60	2,200 00	5,668 00		

* Item 9, Henry J. Mowry, Syracuse, N. Y.—Contract for pier work—awarded. † Item 10, E. H. French, Fulton, N. Y.—Contract for dredging—awarded. ‡ Informal.

Abstract of contracts for each class of materials and labor for improvement of Oak Orchard Harbor, New York, during the fiscal year ending June 30, 1871.

Number.	Names of contractors.	Residence.	Date of contract.	IRON.			STONE.	
				Screw and washer-bolts, price per pound.	Drift-bolts, price per pound.	Spikes, price per pound.	Furnishing stone, price per cord.	Handling stone belonging to United States, price per cord.
1	E. H. French	Fulton, New York	May 22, 1871	......	......	......	......	......
2	Henry J. Mowry	Syracuse, New York	May 27, 1871	$0 6¼	0 4½	$0 6½	$6 50	$1 80
3	Henry J. Mowry	Syracuse, New York	May 27, 1871	......	......	......	......	......

Number.	Names of contractors.	Residence.	Date of contract.	LABOR.					Dredging 30,000 cubic yards, price per cubic yard.
				Towing and sinking cribs, price per crib.	Counter-hewing timber, price per lin. ft.	Timber-work, price per 1,000 ft., (board measure.)	Iron-work, price per pound.	Driving treenails, price per 100.	
1	E. H. French	Fulton, New York	May 22, 1871	......	......	......	......	......	$0 17½
2	Henry J. Mowry	Syracuse, New York	May 27, 1871	......	......	......	......	......	......
3	Henry J. Mowry	Syracuse, New York	May 27, 1871	$50 00	$0 3	$5 50	$0 0½	$8 00	......

Abstract of contracts for Oak Orchard Harbor, New York, during the fiscal year ending June 30, 1871.

No.	Names of contractors.	Residence.	Date of contract.	Nature of contract.
1	E. H. French	Fulton, New York	May 22, 1871	Dredging.
2	Henry J. Mowry	Syracuse, New York	May 27, 1871	Iron and stone.
3	Henry J. Mowry	Syracuse, New York	May 27, 1871	Labor.

Abstract of bids received and opened September 26, 1870, *by Nicholas Bowen, Major Corps of Engineers, for the delivery of stone for crib-filling at the harbor of Oak Orchard, New York.*

No.	Names of bidders.	Residence.	STONE.		Remarks.
			On the shore.	In the pier.	
1	O. J. Jennings	Syracuse, N. Y.	$5 45 per cord.	$6 35 per cord.	Rejected for informality. No witnesses to signatures of guarantors.
2	C. J. De Graw	Fulton, N. Y.	8 50 per cord.	....	Rejected for informality. See bids for Little Sodus Harbor.
3	Edward Short	Niagara, C. West	....	7 60 per cord.	Rejected for informality. See bids for Big Sodus Harbor.

F 3.

REPORT OF OPERATIONS AT THE HARBOR OF CHARLOTTE, NEW YORK.

Work was commenced on the east pier July 27, 1870, and carried on with hired labor, materials being purchased in the open market. During the season two cribs were sunk on the ruins of the old ones at the end of the east pier, and the superstructure on that pier raised and completed as follows: 90 linear feet raised four courses, 120 linear feet raised five courses, and 75 linear feet raised seven courses, all of which was filled with stone and completed.

On the west pier 230 linear feet of the superstructure at the northern extremity was raised three courses, but the close of navigation prevented the completion of the work.

Operations were resumed May 26, 1871, and by the close of the fiscal year the piers were put in complete repair, decayed timber removed in many places and replaced by new, the pier raised in portions that had sunk, and the unfinished part of last season's work completed except planking over about 100 linear feet. The piers are now in good condition, and by having been raised, conspicuously mark the entrance to the harbor. No further work is necessary for this season.

In the spring of 1872, if it is deemed necessary the old deck-plank and part of the superstructure will be removed and replaced by new timber.

Charlotte is a port of entry for Rochester, six miles south of it. There is a fixed white light of the fourth order on shore, and a beacon, with a fixed white light of the sixth order, on the west pier.

The nearest fort is Ontario, sixty miles distant.

Amount expended during the year	$9,141 67
Amount on hand July 1, 1871	$2,858 33
Amount appropriated for the fiscal year ending June 30, 1872	10,000 00
Amount available July 1, 1871	12,858 33

Amount required for fiscal year ending June 30, 1873, nothing.

The amount of revenue collected for the fiscal year was $93,129 16. The value of the imports was $453,477.

The number of vessels that entered the port was 630, with an aggregate tonnage of 62,117 tons, of which 519 vessels, with a tonnage of 50,593 tons, were from foreign ports.

Six hundred and twenty-four vessels cleared, with an aggregate tonnage of 88,232 tons, 513 of them, with an aggregate tonnage of 76,165 tons, being for foreign ports.

There were no contracts made during the year, nor were there any bids received.

F 4.

REPORT OF OPERATIONS AT PULTNEYVILLE, NEW YORK.

There being no material on hand for this work, it was not deemed advisable to purchase in the summer of 1870, but rather to postpone work for one season. As there was a surplus of timber at Genesee River, sufficient for three cribs was purchased from that harbor by authority of the Chief of Engineers, and framed at Charlotte in November, 1870.

In the fall of 1870 proposals were invited for furnishing timber, but the offers was exorbitant and were rejected.

In March, 1871, by authority of the Chief of Engineers, 40,000 feet board measure was purchased in open market.

On the 15th of April, 1871, proposals were invited for materials and labor for building 180 linear feet, more or less, of breakwater, and on the 20th of May the contract was awarded to Mr. H. J. Mowry, of Syracuse, New York.

Mr. Mowry commenced work on the 20th of June, and has succeeded in completing three cribs ready for sinking.

During the present season it is proposed to complete 180 feet of the breakwater running from the west shore. The cribs will be constructed after the Oswego model, with slight modifications.

The project consists of this breakwater, a pier 20 feet wide and 290 feet long, and dredging a channel 10 feet deep at low water to the lake, by removing about 20,000 cubic yards of material.

Amount available July 12, 1870	$5,000 00
Amount expended during the fiscal year ending June 30, 1871	1,023 51
Amount available July 1, 1871	3,976 49
Amount appropriated for fiscal year ending June 30, 1871	5,000 00
Total amount available July 1, 1871	8,976 49
Amount required for fiscal year ending June 30, 1873, to complete the work	23,850 00

Pultneyville is a port of entry in the collection district of Genesee.

The nearest fort is Ontario, forty-two miles to the east, and the nearest light is at Big Sodus, twelve miles distant.

The amount of revenue collected during the fiscal year ending June 30, 1871, at this port, was $1,533 60, and the total tonnage of the vessels entering and clearing was 9,306 tons.

Abstract of bids received and opened October 1, 1870, *by Nicholas Bowen, major corps of engineers, for materials and labor for harbor of Pultneyville, New York.*

Number.	Names of bidders.	Residence.	Class I, hemlock, (sawn.)			Class II, pine, (sawn.)			
			Sticks 30 feet long, per M feet, b. m.	Sticks 20 feet long, per M feet, b. m.	Plank per M feet, b. m.	Sticks 30 feet long, per M feet, b. m.	Sticks 20 feet long, per M feet, b. m.	Sticks 15 feet long, per M feet, b. m.	Plank 20 feet long, per M feet, b. m.
1	S. B. Robinson	Oswego, N. Y	$22	$22	$22	$39 75	$39 75	$39 75	$39 75
2	Charles P. Kellogg	do							
3	Charles J. DeGraw *†	Fulton, N. Y	20	19	18	28 00	28 00	28 00	28 00
4	John King & Co	Oswego, N. Y							
5	O. J. Jennings‡	Syracuse, N. Y	17	15	15	28 00	27 50	22 00	22 00
6	Joshua Granger†	Pultneyville, N. Y							
7	Erie D. Stoddard†	do							
8	Charles H. Hill§	Sodus Point, N. Y							
9	Andrew Holling§	Pultneyville, N. Y	18	18	18	‖32 50	32 50	32 50	32 50

* No charge.
† Informal.
‡ Engineer's estimates.
§ Informal; only one, not in duplicate.
‖ Hewn.

Abstract of bids received and opened October 1, 1870, *by Nicholas Bowen, &c*—Continued.

			Class III, iron.			Class IV, stone.	Class V, dredg'g.	Class VI, labor.	
Number.	Names of bidders.	Residence.	Screw and washer bolts, per pound.	Spikes, per pound.	Drift-bolts, per pound.	Per cord in the cribs.	Per cubic yard.	Framing and sinking, per M feet, b. m.	Iron put in, per pound.
1	S. B. Robinson	Oswego, N. Y	$0 07	$0 06½	$0 05	$7 20	$0 40	†$0 07½	$0 01
2	Charles B. Kellogg	do	06¼	05½	05				
3	Charles J. De Graw*‡	Fulton, N. Y	06	08	05	8 00	40	8 00	(*)
4	John King & Co	Oswego, N. Y	6.7	05½	04⅞				
5	O. J. Jennings §	Syracuse, N. Y	5.4	07	04.3	6 45	(§)	8 00	(*)
6	Joshua Granger ‡	Pultneyville, N. Y				7 25			
7	Erie D. Stoddard ‡	do				7 50			
8	Charles H. Hill ‖	Sodus Point, N. Y						10 00	01
9	Andrew Holling ‖	Pultneyville, N. Y							

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* No charge. † The bid for framing and sinking is supposed to be for one foot, as the price mentioned per M is too low to deserve consideration. ‡ Informal. § Engineer's estimates.

‖ Informal; only one, not in duplicate.

Abstract of proposals for pier-work and dredging at Pultneyville Harbor, New York, opened by Major John M. Wilson, Corps of Engineers, U. S. A., May 15, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—TIMBER.											CLASS II.—IRON.			
			Hemlock timber —46,700 ft. b. m., 10 by 12 inch.		Hemlock plank —5,000 feet b. m., 3 inch.		Canada pine timber—21,120 feet, b. m., 12 by 12 inch.		Pine plank—5,000 ft., b. m., 3 inch.		Snubbing-posts —90 linear feet.		Total amount.	Screw and washer bolts—2,585 lbs.		Drift-bolts—16,612 lbs.	
			Per M ft., b. m.	Amount.	Per M ft., b. m.	Am't.	Per M ft., b. m.	Am't.	Per M ft., b. m.	Am't.	P'r lin'r foot.	Am't.		Per lb.	Am't.	Per lb.	Am't.
*1	Lewis M. Lass	Albion, N. Y	$20 00	$934 00	$20 00	$100 00	$25 00	$528 00	$25 00	$125 00	$0 76	$68 40	$1,755 40	$0 09½	$245 57	$0 05¼	$872 13
†2	Andrew Holling	Pultneyville, N. Y.	20 00	934 00	20 00	100 00	26 00	549 12	26 00	130 00	25	22 50	1,735 62	7½	193 87	5½	913 66
‡3	Samuel G. Hart	Fulton, N. Y	25 00	1,167 50	25 00	125 00	25 00	528 00	25 00	125 00	§25 00	§36 75	1,945 50	6	155 10	6	996 72
4	E. H. French	...do	18 00	840 60	18 00	90 00	30 00	633 60	30 00	150 00	....	....	1,714 20	6	155 10	6	996 72
5	Henry J. Mowry	Syracuse, N. Y	21 00	980 70	21 00	105 00	30 00	633 60	30 00	150 00	50	45 00	1,914 30	6¼	161 56	4⅛	685 24
6	Augustus C. Bowen	Rochester, N. Y	25 00	1,195 52	25 00	125 00	35 50	749 76	35 00	175 00	1 50	135 00	2,380 28	6½	168 02	5½	913 66

Number.	Names of bidders.	Residence.	CLASS II.—IRON.			CLASS III.—STONE.		CLASS IV.—DREDGING.		CLASS V.—LABOR.					Grand total.
			Spikes—600 lbs. 7 inch.		Total amount.	282 cords stone.		500 yards.		Timber-work—176,000 ft., b. m.		Iron-work—20,000 lbs.		Total amount.	
			Per lb.	Amount.		Per cord.	Total amount.	P'r cub. yard.	Total amount.	Per M ft., b. m.	Amount.	Per lb.	Amount.		
1	Lewis M. Lass	Albion, N. Y	$0 07	$42 00	$1,159 70	$8 00	$2,256 00	$1 00	$500 00	$7 00	$1,232 00	$0 01	$200 00	$1,432 00	$7,103 10
2	Andrew Holling	Pultneyville, N. Y.	6½	39 00	1,146 53	6 50	1,833 00	1 00	500 00	15 00 25 00	‖3,990 00	1	200 00	4,190 00	9,495 15
3	Samuel G. Hart	Fulton, N. Y	6	36 00	1,187 82	8 00	2,256 00	70	350 00	8 00	1,408 00	......	....	1,408 00	7,147 32
4	E. H. French	...do	7	42 00	1,193 82	6 00	1,692 00	1 00	500 00	5 00	880 00	1	200 00	1,080 00	6,180 02
5	Henry J. Mowry	Syracuse, N. Y	6¼	37 50	884 30	6 50	1,833 00	85	425 00	5 00	880 00	1	200 00	1,080 00	6,136 60
6	Augustus C. Bowen	Rochester, N. Y	6½	39 00	1,120 68	11 00	3,102 00	1 50	750 00	15 00	2,640 00	10	2,000 00	4,640 00	11,992 96

* Bids for pine timber, exclusive of duties; those would have to be paid by the Engineer Department. Amount not known.

† Bids not made on proper form, being on a sheet of legal-cap paper: bid for timber-work divided, and reads for the 90 feet, for which no framing is necessary, $15 per M feet, board measure, of timber used; for the rest, $25 per M feet, board measure, which is not in accordance with advertisement.

‡ Bids for timber, exclusive of duties; those would have to be paid by the Engineer Department; amount not known. Also failed to bid for snubbing-posts, in accordance with advertisement; aggregate does not include snubbing-posts.

§ Per M feet. Estimated at 1,470 feet, board measure, but not added in total.

‖ Estimated at 41,000 feet, board measure, at $15 00		$615 00
Estimated at 135,000 feet, board measure, at 25 00		3,375 00
	176,000	3,990 00

Abstract of contract for each class of materials and labor for improvement of Pultneyville Harbor, New York, entered into during the fiscal year ending June 30, 1871.

No.	Name of contractor.	Residence.	Date of contract.	Materials.	Am't.	Total.
1	H. J. Mowry ..	Syracuse, N. Y.	June 9, 1871	Timber—		
				Hemlock timber and plank, per 1,000 feet, board measure.	$21 00	
				Pine timber and plank, per 1,000 feet, board measure.	30 00	
				Snubbing-posts, per linear foot.	50	$1, 914 30
				Iron—		
				Screw and washer bolts, per pound.	6¼	
				Drift-bolts, per pound.........	4⅛	
				Spikes per pound..............	6¼	884 30
				Stone—		
				Stone, per cord................	6 50	1, 833 00
				Dredging—		
				Dredging, per cubic yard	85	425 00
				Labor—		
				Timber-work, per 1,000 feet, board measure.	5 00	
				Iron-work, per pound	1	1, 080 00
				Total amount..............	....	6, 136 60

Abstract of contract for Pultneyville Harbor, New York, entered into during the fiscal year ending June 30, 1871.

No.	Name of contractor.	Residence.	Date of contract.	Nature of contract.
1	Henry J. Mowry................	Syracuse, New York......	June 9, 1871	Materials, labor, and dredging.

F 5.

REPORT OF OPERATIONS AT BIG SODUS HARBOR.

Operations were commenced on the west pier July 26, 1870. The light-house crib had listed to the northwest and west, requiring a portion of the old superstructure to be taken off and the work rebuilt and leveled to the proper height corresponding with the pier. This was done, the superstructure filled with stone, and replanked. One hundred and twenty-three feet of the work built in 1869, immediately south of the light-house crib, was overhauled and leveled to correspond with the other work.

The shore end of the west pier was repaired, raising the channel side 1 foot and the lake side 3 feet. This was done by using timber from a crib wrecked the preceding year.

Operations were commenced on the east breakwater in August. This work consisted of placing new cribs over the old work, which had by decay and the action of the elements been razed to the foundations. Quantities of stone and boulders had to be removed, which had accumulated during the series of years the work was out of repair. The cribs were generally 30 feet long, 14 feet wide, and 5 feet deep, with a superstructure 3 feet high. Three hundred and twelve feet of this work was completed.

Big Sodus is a port of entry in the Oswego collection district. Vessels drawing 10 feet can enter the harbor, which is one of the best on the lake; but the material of the bottom, between the piers, being a very fine sand, is continually shifting. It is thought that after the east breakwater is completed, and the channel dredged out, the water from the bay, emptying into the lake, will have sufficient velocity to maintain a proper depth. There is a fixed light, varied by flashes of the fourth order, at this place, and two beacon-lights as ranges for the pier. Fort Ontario is the nearest work of defense.

It is not proposed to do any work at Big Sodus this season, the funds available not being sufficient. Proposals will be asked in the fall for timber for the east breakwater.

Amount available July 11, 1870	$5, 957 82
Amount expended during the year	4, 733 64
Amount available July 1, 1871	1, 224 18
Amount required for fiscal year ending June 30, 1873	45, 000 00

which will complete this harbor, dredging a channel 12 feet deep between the piers by removing about 120,000 cubic yards of earth, finish the east breakwater, and renew all decayed superstructure.

I have been unable to obtain the commercial statistics of this place for the fiscal year. The deputy collector has informed me that he has held the appointment for only a portion of the year, and that his predecessor left no records in the office.

Abstract of bids received and opened September 24 by Nicolas Bowen, major corps of engineers, for the delivery of stone for crib-filling at harbor of Big Sodus, New York.

Number.	Names of bidders.	Residence.	Stone, per cord.		Remarks.
			On the banks.	In the crib.	
1	O. J. Jennings.	Syracuse, N. Y.	$5 90	$6 45	Rejected for informality. No witnesses to signatures of guarantors.
2	Edward Short.	Niagara, C. W.		8 20	Rejected for informality. No witnesses to signatures of guarantors. Bid does not state whether on the banks or in the cribs; supposed to be the latter.

F 6.

REPORT OF OPERATIONS AT THE HARBOR OF LITTLE SODUS.

Operations were commenced at this locality on July 28, 1870, the survey of the harbor, which had been in progress up to that time, being completed. The work was carried on by hired labor and purchase of materials in the open market. Two hundred and fifty-six feet of the west pier was leveled up and filled with stone, and in August a breakwater, running west from the west pier to the beach, was commenced. This work is constructed after the Oswego model, modified—the crib-work being 30 feet by 10 feet. Two hundred and ten feet of crib-work was placed in position, and 100 feet of superstructure completed. The heavy gales in October caused considerable damage to the unfinished work, and the progress was delayed. Five cribs were constructed, but could not be sunk on account of the weather.

In September, 1870, proposals were invited for stone, but were all rejected, and the purchases made in open market. Operations for the season were suspended November 28, 1870.

In May, 1871, proposals were invited for repairing the pier, completing the breakwater, building a pier-head for a light, and dredging the harbor. The work was awarded to Mr. E. H. French, of Fulton, New York.

During the present season it is proposed to finish the breakwater joining the pier with the west shore, to build a crib 30 feet square at the outer end of the pier for a light, to repair the pier for a distance of 350 feet by raising the east side to the proper level, and to dredge a channel at the entrance of the harbor 200 feet wide and 12 feet deep at mean low water, by removing about 20,000 cubic yards of material.

In order to complete this harbor I think that there should be a short east pier and a breakwater connecting it with the east shore. These are required not only to define the channel, but also to so contract the flow of water passing into the lake as to give it a sufficient velocity to keep the channel always open, and to protect the harbor from the effect of northerly and easterly winds.

Were it probable that the commerce of Little Sodus would remain in its present insignificant state, I would hesitate to recommend further improvement; but as it is stated that the Southern Central Railroad will be completed to this point during the present year, it is presumed that it will add greatly to the commercial importance of the place.

I therefore respectfully recommend that an east pier about 500 feet long shall be constructed parallel to, and 250 feet from, the west pier, and that its inner end be connected with the east shore by a breakwater 1,800 feet long, the whole to be constructed of cribs 30 feet by 20 feet, built after the Oswego model, with such modifications as may be deemed necessary. The amount required for this would be:

For 500 feet of pier, at $45 per foot	$22,500
For 1,800 feet of breakwater, at $22 per foot	39,600
Total	62,100

Little Sodus is a port of entry in the collection district of Oswego.

Fort Ontario, fifteen miles distant, is the nearest work of defense, and the lights of Oswego and Big Sodus are each fifteen miles distant. It is proposed during the coming year to place here a fixed white light of the fourth order.

Amount expended during fiscal year ending June 30, 1871	$4,775 93
On hand July 1, 1871	288 48
Amount appropriated for fiscal year ending June 30, 1872	15,000 00
Amount available July 1, 1871	15,288 48
Amount required for fiscal year ending June 30, 1873	22,500 00

The deputy collector of this port was unable to furnish the commercial statistics required. He informs me that he has held the appointment since the 19th of May, 1871, and during the time up to the close of the fiscal year there had been no imports and no revenue collected.

Abstract of bids received and opened September 26, 1870, by Nicolas Bowen, major of engineers, for the delivery of stones for crib-filling, at the harbor of Little Sodus, New York.

Number.	Names of bidders.	Residence.	Stone, per cord.		Remarks.
			On the shore.	In the pier.	
1	O. J. Jennings	Syracuse, N. Y.	$5 70	$6 65	Rejected for informality. No witnesses to signatures of guarantors.
2	Charles J. De Graw.	Fulton, N. Y.	8 00	....	Rejected for informality. No witnesses to signatures of guarantors. See bids for Oak Orchard, and also on the ones for Little Sodus.

Abstract of proposals for materials, pier-work, and dredging at Little Sodus Harbor, N. Y., opened by Major John M. Wilson, corps of engineers U. S. A., June 3, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—TIMBER.											CLASS II.—IRON.				
			Canada white pine, 12" by 12", 47,520 ft. b. m.		Can'a white pine, 6" by 12", 4,320 ft. b. m.		Can'a white pine, 3" plank, 9,360 ft. b. m.		Hemlock, 12" by 12" by 35", 41,400 ft. b. m.		Treenails, 112.			Screw and washer bolts, 666 lbs.		Drift bolts, 6,366 lbs.		
			Per M feet, b. m.	Amount.	Per M feet, b. m.	Amount.	Per M feet, b. m.	Amount.	Per M feet, b. m.	Amount.	Per 100.	Amount.	Total.	Per lb.	Amount.	Per lb.	Amount.	Total.
1*	Peter Lamoree, Wm. Crowley, and James Oates.	Oswego, N. Y.	.....	$1,375 20	$16	$69 12	$16	$149 76	$17	$703 80	$6	$6 72	$2,304 60	$0 10	$66 60	$0 07	$445 62	$512 22
2	C. P. Morse & Co.	Oswego, N. Y.	....	....	....	......	....	......	....	....	....	......	....	....	......	....	......	......
3	Wm. S. Malcolm	Oswego, N. Y.	....	....	....	......	....	......	....	....	....	......	....	....	......	....	......	......
4	R. Nelson Gere	Syracuse, N. Y.	$29	1,378 08	29	125 28	29	271 44	23	952 20	10	11 20	2,738 20	06¼	41 62	04¼	270 55	312 17
5	Samuel G. Hart	Fulton, N. Y.	25	1,188 00	25	108 00	25	234 00	25	1,035 00	5	5 60	2,570 60	06	39 96	06	381 96	421 92
6†	E. H. French	Fulton, N. Y.	27	1,283 04	27	116 64	27	252 72	20	828 00	5	5 60	2,486 00	06	39 96	04	254 64	294 60
7‡	E. H. French	Fulton, N. Y.	....	....	....	......	....	......	....	....	....	......	....	....	......	....	......	......

Number.	Names of bidders.	Residence.	CLASS III.—STONE.					CLASS IV.—LABOR.										CLASS V.—DREDGING.	
			Handling stone, 14 cords.		Furnishing 240 cords.			Moving and sinking 8 cribs.		Timber-work, 110,000 ft., b. m.		Iron-work, 9,500 lbs.		Driving treenails, 112.				20,000 cubic yards.	
			Per cord.	Amount.	Per cord.	Amount.	Total.	Per crib.	Amount.	Pr. M ft., b. m.	Amount.	Per lb.	Amount.	Per 100.	Amount.	Total.	Grand total.	Per cub. yard.	Amount.
1*	Peter Lamoree, Wm. Crowley, and James Oates.	Oswego, N. Y.	$3 00	$42	$7 00	$16 80	$1,722	$20	$160	$8 00	$880 00	....	......	....	......	$1,040 00	$5,578 82	......	....
2	C. P. Morse & Co.	Oswego, N. Y.	.....	....	.....	.....	.....	....	....	.....	....	....	......	....	......	....	....	$0 18	$3,600 00
3	Wm. S. Malcolm	Oswego, N. Y.	.....	....	.....	.....	.....	....	....	.....	....	....	......	....	......	....	....	25	5,000 00
4	R. Nelson Gere	Syracuse, N. Y.	3 00	42	6 50	15 60	1,602	30	240	6 25	687 50	$ 01½	$142 50	$2	$2 24	1,072 24	5,724 61	23	4,600 00
5	Samuel G. Hart	Fulton, N. Y.	2 00	28	7 50	18 00	1,828	20	160	10 00	1,100 00	01	95 00	1	1 12	1,356 12	6,176 64	......	....
6†	E. H. French	Fulton, N. Y.	2 50	35	6 00	14 40	1,475	20	160	6 00	660 00	01	95 00	2	2 24	917 24	5,172 84	......	....
7‡	E. H. French	Fulton, N. Y.	.....	....	.....	.....	.....	....	....	.....	....	....	......	....	......	....	....	17	3,400 00

*43,920 feet, b. m., at $30; 3,600 feet, b. m., at $16 = 47,520 feet, b. m., for $1,375 20.

† Materials and pier-work awarded to E. H. French.

‡ Dredging awarded to E. H. French.

Abstract of contracts for each class of materials and labor for Little Sodus Harbor, New York, for the fiscal year ending June 30, 1871.

Number.	Names of contractors.	Residence.	Date of contract.	TIMBER.			IRON.		STONE.		LABOR.				DREDGING.
				Canada white pine timber and plank.	Hemlock timber.	Treenails.	Screws and washer bolts.	Drift-bolts.	Handling stone belonging to the United States.	Furnishing stone.	Moving and sinking cribs, previously framed.	Timber work.	Iron works.	Driving treenails.	20,000 cubic yds., more or less.
				Per 1,000 ft., b. m.	Per 1,000 ft., b. m.	Per hundred.	Per lb.	Per lb.	Per cord.	Per cord.	Per crib.	Per 1,000 ft., b. m.	Per lb.	Per hundred.	Per cubic yard.
1	E. H. French..	Fulton, N. Y..	June 16, 1871	....	....	....	....	....	....	....	....	....	....	....	$0 17
2	E. H. French..	Fulton, N. Y..	June 16, 1871	$27 00	$20 00	$5 00	$0 06	$0 04	$2 50	$6 00	$20 00	$6 00	$0 01	$2 00	....

Abstract of contracts for improvement of Little Sodus Harbor, New York, during the fiscal year ending June 30, 1871.

No.	Names of contractors.	Residence.	Date of contract.	Subject of contract.
1	E. H. French	Fulton, N. Y.	June 16, 1871	Dredging.
2	E. H. French	Fulton, N. Y.	June 16, 1871	Materials and labor.

F 7.

REPORT OF OPERATIONS AT THE HARBOR OF OSWEGO, NEW YORK.

Operations were commenced upon the new pier running out from the light-house on the 23d of July, 1870. One crib not before leveled was built up to the low-water line, and during the season the superstructure was put upon the whole pier, 437 feet in length.

The opening of navigation found the old pier in a dilapidated condition, and extensive repairs were necessary. One hundred and twenty feet of superstructure next to the stone breakwater was renewed, and outside and deck planking put on. Several breaches were repaired, portions leveled and filled with stone, and work continued upon the structure until the fall, when the old pier was in apparently good condition.

In November a crib was constructed for the new outer breakwater, but the severe weather prevented it from being placed in position.

During the fall about 600 cords of stone were quarried, in anticipation of prosecuting the work in the spring of 1871.

Work was closed for the season in December, 1870, having been carried on entirely by hired labor. During the winter about 500,000 feet, board measure, of hemlock timber, and 350,000 feet, board measure, of pine, was ordered for the new breakwater.

After the disappearance of the ice in the spring of 1871, it was found that considerable damage had been done to the old pier, and proposals were invited for supplying labor and materials for its repair, and for building a short breakwater in the angle near the light-house, the shock of the waves at the latter place being so severe as to seriously affect the light. The work was awarded on May 29 to Mr. Thomas Keeler, who commenced operations on the 5th of June, and has pushed them forward with energy. The repairs are nearly completed, and the crib for the angle is prepared.

The lake front has been re-sheathed in many places, decayed timber removed from the superstructure and replaced by new, and several small cribs sunk in places where the former ones had been entirely destroyed.

On May 3, 1871, proposals were invited for labor and materials for the new breakwater. The stone and labor were awarded to Mr. R. Nelson Gere, of Syracuse, the timber and iron to Mr. E. H. French, the lowest bidders for those classes. Mr. French declined the award, Mr. Gere accepted, and contracts were executed accordingly. Work was commenced on the 1st of July, 1871, and is being energetically forwarded.

During the present season it is proposed to complete the repairs of the old breakwater, to construct a short breakwater across the angle near the light-house, and to build about 600 feet of the new breakwater. The work will all be done by contract, except the purchase of timber and iron for the new breakwater, which will be made in the open market.

Oswego is the most important harbor on the lake. The receipts at the custom-house bear favorable comparison with those of the larger harbors in the country. The very able and exhaustive report of my distinguished predecessor, the late lamented Major Bowen, fully shows the importance of the early completion of a commodious harbor at this place.

This is the point from which four of the most important products of the country are distributed—grain, lumber, coal, and salt—and the trade in the last three of these is seriously embarrassed by the want of sufficient wharf room for their accommodation. Lumber especially suffers from this cause, and I have been informed that during the last season 60,000,000 feet, board measure, of timber from one point alone was diverted from this port for that reason, and from lumber the General Government annually derives a large revenue.

Since the last annual report the New York and Oswego Midland Railroad Company have contracted for the last section of their road, and by the close of 1872 this route will be open to New York. The Lake Ontario Shore Railroad Company are about to commence work upon their line, and it is anticipated that before the close of this fiscal year they will have effected a junction with the Southern Central Railroad, and thus open a new route to the great coal-fields of Pennsylvania.

Projects for new roads to Portland and Boston are being strongly agitated.

Amount required to complete the work	$1,050,000 00
Amount expended during the year	35,991 17
Amount available July 1, 1871	126,327 17
Amount required for the fiscal year ending June 30, 1873	300,000 00

Fort Ontario is situated here. There is a light-house, exhibiting a fixed white light of the third order.

Oswego is a port of entry. The amount of revenue collected here during the fiscal year was $798,288. The value of the imports was $6,804,977.

Four thousand two hundred and fifty-six vessels, with an aggregate tonnage of 707,929 tons, entered during the year, and 6,050, with an aggregate tonnage of 894,592 tons, cleared.

Abstract of bids received and opened October 14, 1870, by Nicholas Bowen, major of engineers, for materials for enlargement of harbor facilities at Oswego, New York.

			CLASS I.—HEMLOCK TIMBER.		CLASS II.—PINE TIMBER.	CLASS III.—IRON BOLTS.		CLASS IV.—BAR-IRON
Number.	Names of bidders.	Residence.	12 by 12 inch by 35-foot sticks, (780,) per M feet, b.m., 327,600, b.m.	12 by 3 inch by 34-foot plank, (45,) per M feet, b.m., 4,590, b.m.	12 by 12 inch by 35-foot sticks, (100,) per M feet, b.m., 42,000, b.m.	38 by 1¼ inch screw and washer bolts, (360,) per lb., 6,600 lbs.	30 by 1¼ inch drift-bolts, (2,875,) per lb., 24,437 lbs.	Bar-iron, 7,800 linear feet, per lb., 26,420 lbs.
1	*Doolittle, Dunn & Co	Oswego, N. Y						$0 04
2	Reid & Cooper	Elmira, N. Y				$0 06¼	$0 05	04⅝
3	†R. Nelson Gere	Syracuse, N. Y				06¼	04⅜	03, 7
4	John King & Co	Oswego, N. Y				06¼	04⅝	
5	‡Mannister Worts	do	$24	$24				
6	J. N. Collins & Co	do						03¾
7	§Post & Henderson	do			$38			
8	‖Post & Henderson	do	30	30				
9	¶Charles J. De Graw	Fulton, N. Y	31	31	39	06	05	04¼

* Informal. No seal to sureties' names.
† Informal. No seal to sureties' names.
‡ Informal. No seal to sureties' names. Guarantee not certified.
§ Informal. No seal to sureties' names.
‖ Informal. No seal to sureties' names. Guarantee not certified on duplicate.
¶ Informal. No seal to sureties' names.

Abstract of bids for repairs of Oswego pier, N. Y., opened by John M. Wilson, major of engineers, May 20, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—TIMBER.					CLASS II.—IRON.			
			12 by 6-inch by 20-foot pine timber, 1,200 feet board measure.		3-inch pine plank, 20,000 feet board measure.			Iron washers, 240 pounds.		12-inch spikes, 1,500 pounds.	
			Per M. feet board measure.	Amount.	Per M. feet board measure.	Amount.	Total.	Per pound.	Amount.	Per pound.	Amount.
1	John Shephard and Patrick Hourihan	Oswego, N. Y	$26 00	$31 20	$22 00	$440 00	$471 20	$0 08	$19 20	$0 05¾	$86.25
2	Thomas Keeler*	Fulton, N. Y	29 00	34 80	29 00	580 00	614 80	09	21 60	07	105 00
3	Peter Lamoree and James Oates	Oswego, N. Y	30 00	36 00	26 00	520 00	556 00	10	24 00	06½	97 50

Number.	Names of bidders.	Residence.	CLASS II.—IRON—Con.			CLASS III.—LABOR.							Grand total.
			7 and 9-inch spikes, 2,300 pounds.			Handling stone belonging to the U. S., 150 cords.		Timber-work on 81,000 ft. board measure.		Iron-work on 12,000 pounds.			
			Per pound.	Amount.	Total.	Per cord.	Amount.	Per M. feet board measure.	Amount.	Per pound.	Amount.	Total.	
1	John Shephard and Patrick Hourihan	Oswego, N. Y	$0 05¾	$132 25	$237 70	$3 50	$525 00	$12 00	$972 00	$0 02½	$300 00	$1,797 00	$2,505 90
2	Thomas Keeler*	Fulton, N. Y	07	161 00	287 60	5 00	750 00	5 50	445 50	01	120 00	1,315 50	2,217 90
3	Peter Lamoree and James Oates	Oswego, N. Y	06½	149 50	271 00	4 00	600 00	9 00	729 00	01	120 00	1,449 00	2,276 00

* Awarded.

Abstract of proposals for materials and labor for the new breakwater at Oswego Harbor, New York, opened by Major John M. Wilson, Corps of Engineers, United States Army, June 3, 1871.

Number.	Names of bidders.	Residence.	CLASS I.—TIMBER. 12×12 in. hemlock timber—758,520 feet b. m.		3-in. hemlock plank 15,345 feet b. m.		12×12 inch Canada pine, 277,200 feet b. m.		6×12 inch Canada pine, 27,750 feet b. m.		3-inch Canada pine pl'k, 65,100 feet b. m.		270 linear feet, or 4,500 feet b. m., snubbing posts.			2,700 treenails.		Total.	CLASS II.—IRON. 1,768 lbs. washers.		95,000 lbs. drift-bolts.		3,400 lbs. 7 & 9 inch spikes.	
			Per M. ft. b. m.	Amount.	Per M. ft. b. m.	Amount.	Per M. ft. b. m.	Amount.	Per M. ft. b. m.	Amount.	Per M. ft. b. m.	Amount.	Per M. ft. b. m.	Per linear foot.	Amount.	Per 100.	Amount.		Per lb.	Amount.	Per lb.	Amount.	Per lb.	Amount.
																			ct.		*ct.*		*ct.*	
1	Franklin Deecker	Rochester, N. Y.	$20	$15,170 40	$16	$245 52	$28	$7,761 60	$21	$582 75	$20	$1,302 00	....	$1½	$405 00	$6	$162 00	$25,629 27	6½	$114 92	6	$5,700 00	6½	$221 00
2	Charles J. DeGraw	Fulton, N. Y	18	13,653 36	18	276 21	25	6,930 00	25	693 75	25	1,627 50	$40	....	180 00	7	189 00	23,549 82	5	88 40	4	3,800 00	6	204 00
3	C. M. Hemenway & A. K. Garfield	Painesville, Ohio	20	15,170 40	20	306 90	22¾	6,306 30	22¾	631 31	22¾	1,481 02	50	....	225 00	10	270 00	24,390 93	8	141 44	4¼	4,037 50	5¼	178 50
4	E. H. French	Fulton, N. Y	18	13,653 36	18	276 21	18	4,989 60	18	499 50	18	1,171 80	45	...	202 50	5	135 00	20,927 97	6	106 08	4	3,800 00	7	238 00
5	R. Nelson Gere	Syracuse, N. Y.	29	21,997 08	29	445 00	34	9,424 80	34	943 50	34	2,213 40	....	½	135 00	8	216 00	35,374 78	6½	114 92	4⅛	3,918 75	6	204 00
6	Samuel G. Hart	Fulton, N. Y	26	19,721 52	26	398 97	26	7,207 20	26	721 50	26	1,692 60	26	....	117 00	..	......	*29,858 79	5	88 40	5	4,750 00	5	107 00
7	B. M. Pratt	Fulton, N. Y	25	18,936 00	16	245 52	35	9,702 00	25	693 75	25	1,627 50	....	....	....	5	135 00	†31,366 77	8	141 44	5	4,750 00	8	272 00

Number.	Names of bidders.	Residence.	CLASS II—IRON—Con. 2,300 lbs. screw and washer bolts.		Total.	CLASS III—STONE. Handling 500 cords belonging to U. S.		Furnishing 4,600 cords.		Total.	CLASS IV—LABOR. Removing 150 yards gravel & boulders.		Timber-work on 1,840,000 feet, b. m.		Iron-work on 132,000 pounds.		Driving 2,700 treenails.		Total.	Grand total.
			Per lb.	Amount.		Per cord.	Amount.	Per cord.	Amount.		Per yard.	Amount.	Per M. ft. b. m.	Amount.	Per lb.	Amount.	Per 100.	Amount.		
			cts.												*cts.*					
1	Franklin Deecker	Rochester, N. Y.	6½	$149 50	$6,185 42	$7 00	$3,500 00	$9 50	$43,700	$47,200	$0 60	$90 00	$10 00	$18,400	10	$13,200	$40	$1,080	$32,770 00	$111,784 09
2	Charles J. DeGraw	Fulton, N. Y	9	207 00	4,299 40	3 00	1,500 00	6 00	27,600	29,100	80	120 00	8 00	14,720	1	1,320	1	27	16,187 00	73,136 22
3	C. M. Hemenway & A. H. Garfield	Painesville, Ohio	8	184 00	4,541 44	3 50	1,750 00	5 85	26,910	28,660	40	60 00	7 50	13,800	1	1,320	15	405	15,585 00	73,177 37
4	E. H. French	Fulton, N. Y	6	138 00	4,282 08	5 00	2,500 00	6 40	29,440	31,940	35	52 50	9 00	16,560	1	1,320	3	81	18,013 50	75,163 55
5	R. Nelson Gere	Syracuse, N. Y	....	....	‡4,237 67	3 50	1,750 00	5 75	26,450	28,200	75	112 50	5 75	10,580	1¼	1,650	5	135	12,477 50	80,289 95
6	Samuel G. Hart	Fulton, N. Y	5	115 00	5,123 40	4 00	2,000 00	9 00	41,400	43,400	1 00	150 00	8 00	§14,720	....	(§)	....	(§)	14,870 00	93,252 19
7	B. M. Pratt	Fulton, N. Y	7	161 00	5,324 44	5 50	2,750 00	10 25	47,150	49,900	40	60 00	12 50	23,000	1¼	1,650	2	54	24,764 00	111,355 21

* Exclusive of treenails. † Exclusive of snubbing-posts. ‡ Exclusive of screw and washer bolts. § The bid for timber-work includes iron-work and driving treenails.

Abstract of contracts for each class of materials and labor for Oswego Harbor, New York, for the fiscal year ending June 30, 1871.

Number.	Names of contractors.	Residence.	Date of contract.	TIMBER.	IRON.			STONE.		LABOR.			
				Pine timber and plank.	Wrought washers.	12 and 9 inch spikes.	Drift-bolts.	Handling stone belonging to the United States.	Furnishing stone.	Removing gravel, boulders, &c.	Timber-work.	Iron-work.	Driving treenails.
				Price per M. ft. b. m.	Price per pound.	Price per pound.	Price per pound.	Price per cord.	Price per cord.	Price per cubic yard.	Price per M. ft. b. m.	Price per pound.	Price per hundred.
1	R. Nelson Gere	Syracuse, N. Y	Dec. 15, 1870				$0 4½						
2	Thomas Keeler	Fulton, N. Y	June 12, 1871	$29 00	$0 09	$0 07		$5 50			$5 50		
3	R. Nelson Gere	Syracuse, N. Y	June 20, 1871					3 50	$5 75	$0 75	5 75	$0 1¼	$5 00

Abstract of contract for improvement of Oswego Harbor, New York, during the fiscal year ending June 30, 1871.

No.	Names of contractors.	Residence.	Date of contract.	Subject of contract.
1	R. Nelson Gere	Syracuse, N. Y	December 15, 1870	Iron.
2	Thomas Keeler	Fulton, N. Y	June 12, 1871	Materials and labor.
3	R. Nelson Gere	Syracuse, N. Y	June 20, 1871	Stone and labor.

F 8.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., May 25, 1871.

SIR: I beg leave to submit for your consideration a report, with accompanying papers, of a board of engineer officers reconvened at Oswego, New York, on the 17th instant, to take into consideration all matters relating to the proper application of the recent appropriation for the improvement of this harbor.

The breakwater planned for Oswego Harbor has for its object to afford anchorage and wharfage room. The entrance to Oswego Harbor is difficult in westerly storms. To facilitate it and render it safe, an exterior breakwater was planned many years ago and its construction urged. Since that time the commerce of the town has greatly increased, and the harbor being small is no longer adequate to the fast-growing lake trade. The recently planned breakwater comprised both objects, anchorage and additional wharfage room.

The question arose under the recent appropriation for Oswego Harbor, whether the breakwater should be commenced at the western end, where it connects with the shore, about a mile from the entrance to Oswego Harbor, or at the east end, opposite the entrance to the harbor. By beginning at the east end the anchorage facilities would be gained first; the additional wharfage room, only upon the completion of the breakwater five or six years hence.

By beginning at the west end the anchorage facilities would be gained last, the wharfage space first; but, in the opinion of the senior officer of the board, this wharfage space would scarcely be available in storms until toward the completion of the breakwater. The anchorage facilities bear upon the safety of the whole lake trade of the port, and may be considered of more national character than the wharfage space, which is local in its nature.

The town of Oswego has unanimously requested that the breakwater be begun at its western end, as more wharfage room is what they need most pressingly, and the board of engineer officers recommend that this request be acceded to, although adhering to the individual opinions, as severally expressed by them in their preceding reports and communications, as to the advantages to be obtained for the security of navigation by beginning at the east end, which they then recommended.

I concur in the view of the board that it would be advisable, under the circumstances, to begin the construction of the breakwater at the west end.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

The views of the Chief of Engineers and the board are approved by the Secretary of War.

JOHN POTTS,
Chief Clerk, War Department.

MAY 27, 1871.

OSWEGO, NEW YORK, *May* 18, 1871.

GENERAL: I transmit herewith the report of the proceedings and conclusions of the board of engineer officers, reconvened by Special Order 60, of May 10, 1871, and in pursuance of your instructions of May 11, 1871, to consider the communication of Messrs. Churchill and Grant, relative to the point of commencing the new work adopted for enlarging the capacity of the harbor of Oswego, New York.

The original communications accompanying your letter of instructions are also returned.

Very respectfully, your obedient servant,

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
Washington, D. C.

OSWEGO, NEW YORK, *May* 18, 1871.

GENERAL: The board of engineer officers, reconvened at Oswego, New York, by Special Orders No. 60, dated Headquarters Corps of Engineers, Washington, D. C., May 10, 1871, met at Oswego, New York, May 17, 1871, all the members being present; and, in accordance with its letter of instructions, proceeded to consider the communication of Messrs. Churchill and Grant to the Chief of Engineers, concerning the expediency of beginning work on the proposed Oswego pier and breakwater at the westerly or shore end, instead of at an easterly point, as recommended by this board at its session of April 15, 1871. The papers forwarded by the Chief of Engineers, to assist in the deliberations of the board, were duly consulted. In obedience to the Chief of Engineers' instructions, that the board should make full inquiries upon all points presented in the communication of Messrs. Churchill and Grant, and a thorough investigation of all facts bearing upon the question under consideration, the board, by letter, invited the Board of Trade of Oswego to lay before this board expressions of opinion, in writing, by either its members, or other citizens of Oswego interested in Oswego Harbor improvements. The reply of the Board of Trade, and other expressions of opinion of prominent citizens and the city corporation, are appended to this report. Pending their reception, however, the board proceeded to take up and discuss *seriatim*, point by point, the objections made by Messrs. Churchill and Grant to commencing work on the Oswego breakwater at an easterly point, and their arguments in favor of starting the construction at the westerly or shore end. Their memorial was duly considered, thoroughly discussed, and disposed of as follows:

The question was first considered, What are the purposes for which the new harbor is intended? In reply to which the board unanimously decided that it was to afford both anchorage and wharfage; then, taking up the objections and arguments of the memorialists, Messrs. Churchill and Grant, in regular order, the following questions were considered and conclusions arrived at:

1. By beginning construction at the eastern end of the projected work, will the use of the new harbor, for the purposes for which it is intended, be delayed?

Answered as follows: Lieutenant Colonel Woodruff, no.—Major Wilson, yes.—Captain Harwood, as to wharfage, yes; as to anchorage, no.

2. The board then unanimously concurred in the statements of the memorialists, that it would probably be five or six years before the work could be completed; that no wharfage could be obtained until the western end should be connected with the shore; and that the proximity of the 12-feet line of soundings to the line of proposed work, at a point about three-fifths of the distance from the eastern end of the project, would not warrant the conclusion that this shoaling would shelter an area to the eastward.

3. The question was then considered, With the western end unconnected with the shore, would anchorage in a westerly storm be unsafe?

Answered as follows: Lieutenant Colonel Woodruff and Captain Harwood, no.—Major Wilson, yes.

4. The board unanimously concurred in the statements of the memorialists that by commencing at the western end, as soon as the pier should have been extended beyond the angle a few hundred feet, it would be safe to commence at once the erection of wharves along the shore, and that these would increase in number continually in proportion to the rate of extension of the work to the east. As to the availability of such wharves in stormy weather, the board was, however, divided in opinion; Lieutenant Colonel Woodruff holding that they could not be available for purposes of commerce during stormy weather until the entire pier and breakwater was completed, whereas the other members held that they would be so available in westerly, northwesterly, and southwesterly storms.

5. The board unanimously concurred in the statement of the memorialists that a prompt increase of wharfage at Oswego is a matter of prime importance to its commerce.

6. The board unanimously concurred in the statement, that by commencing at the western end of the project the storage facilities for material would be increased, but on the other hand was of opinion that owing to shoalness of water at that locality cribs could not be built and launched to advantage, but would, in any event, until the work was greatly advanced, have to be built in the present harbor and towed to their respective sites.

7. The board granted that by sinking cribs at the easterly end of the project a temporary obstruction to navigation would be offered, but is of the opinion that this objection is not a serious one, inasmuch as by proper advertising of notices to mariners sufficient publicity would be given to the obstructions to insure its being readily avoided, especially by the aid of range-lights.

8. The board does not consider the difference of expense of commencing at the east or west end of the work a matter of importance, inasmuch as the whole is to be built eventually, and the expense will be nearly the same in the end in either event.

9. The board does not concur in the fifth objection of the memorialists, apprehending no danger to either old or new works from any change in the formation of ice due to the presence of the breakwater.

The board has thus taken up *seriatim* and disposed of all the points presented in the communication of Messrs. Churchill and Grant, after having made full inquiries upon them, and a thorough investigation of all the facts bearing upon the matter in question. Full opportunity has been given to the citizens of Oswego to express their opinions resulting in the reception by the board of the documents herewith transmitted, by which it will be seen that the community are unanimously in favor of having the work commenced at the westerly or shore end of the project, and built thence easterly. There has been no dissent expressed to the board, to this desire so fully set forth in the papers submitted to the board from various individuals and public corporations.

To relieve their present harbor by obtaining increased wharfage facilities, as soon as possible, is apparently considered an object of paramount importance, overruling every other consideration, and the board has in this report expressed its opinion that no wharfage can be obtained until the western end of the breakwater is connected with the shore.

In view, therefore, of these conclusions, and the unanimous wish of the community that the work should be begun at the shore end, the board, while its individual members still adhere to their several opinions, as expressed in this and preceding reports and communications, seeing no serious objection to yielding to the wish of the community, reverses the decision made at its session of April 15, 1871, and respectfully recommends that the Oswego pier and breakwater be commenced at the westerly or shore end and built thence eastwardly until the project is completed.

The papers and documents which have been before the board during its deliberations, and upon which its decision is based, are herewith respectfully transmitted, in number and order as indicated in the accompanying abstract.

We have the honor to be, general, very respectfully,

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
JOHN M. WILSON,
Major Engineers, U. S. A.
F. HARWOOD,
Captain Engineers.

The CHIEF OF ENGINEERS, *U. S. A.*

OSWEGO, N. Y., *April* 15, 1871.

GENERAL: I have the honor to transmit herewith the report of the board of engineer officers, constituted by Special Orders 42, Headquarters Corps of Engineers, Washington,

D. C., April 10, 1871, and in conformity to your instructions of the same date, relative to point of commencing the proposed works for enlarged harbor facilities at Oswego, N. Y.

Very respectfully, your obedient servant,

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.

The CHIEF OF ENGINEERS, *U. S. A.,*
Washington, D. C.

OSWEGO, N. Y., *April* 15, 1871.

GENERAL: The board of engineer officers convened by virtue of Special Orders No. 42, dated Headquarters Corps of Engineers, Washington, D. C., April 10, 1871, (a copy appended and marked A,) met at Oswego, New York, April 14, 1871, and proceeded to the consideration of the subject upon which they were ordered to deliberate by the letter of instructions from the Chief of Engineers, (a copy appended and marked B,) and studied the subject in the light of the papers and records referred to in that letter of instructions. All the members having been present, and having duly considered and discussed the question of the proper location and point of commencement of the section of Oswego breakwater to be constructed with the available appropriation, the board finally determined upon the following report:

The board is instructed that it is "of the first importance that the appropriation" for Oswego Harbor "shall be applied so that the greatest benefit to commerce, and protection to existing works, may be derived from the expenditure," and is required to consider "the question as to the point of commencing the work in the line of proposed pier and breakwater, whether at the shore end, the eastern, or some intermediate point, say at that point of the proposed breakwater nearest the 12-foot curve, at about 3,000 feet from the eastern end," and to "report their views, with a recommendation as to the proper point to commence the work."

The board is adverse to building, at present, at the western extremity of the project of the board of 1870, inasmuch as the result would be simply the formation of an isolated harbor, a mile away from the present one, and with no communication in stormy weather.

The board is of the opinion that the greatest benefit to commerce would result, and the protection of existing works be sooner attained, by applying the appropriation to the construction of an easterly section of the proposed breakwater, thereby obtaining at the earliest possible date an accessible and convenient anchorage for vessels putting into the present harbor of Oswego under stress of weather. To protect existing works to any available degree would require, however, the interposition lakeward of a section of breakwater from 1,500 to 2,000 feet in length. This object, therefore, in the opinion of the board, cannot be obtained under three years time, even supposing liberal annual appropriations to be made. But every foot of work built on an easterly section of the breakwater, properly located with reference to existing exposed works, will, however, tend to their ultimate security.

As to the points of commencement of work proposed for the discussion of the board, the shore end has already been disposed of by adverse report upon the building at present of a westerly section of the proposed work. To build from a point about 3,000 feet from the eastern end of the project of the board of 1870, and near the 12-foot curve, would, in the opinion of the board, be unadvisable, inasmuch as in so doing it would take two or more years to obtain either a western detached harbor, or an eastern anchorage convenient to the present harbor. An examination of the project of the board of 1870 leaves this board in doubt as to whether about 250 feet of the easterly end of the proposed breakwater will be necessary. As this is a question which experience during the construction of the work can alone decide, the board, in selecting a point for starting the eastern section of breakwater, herein proposed for immediate construction, is disposed to leave this extreme eastern section as a question of the future. Again, the practical advantages in laying an exposed work, resulting from working toward the direction of attack from prevailing heavy seas, rather than from it, disposes the board to recommend the building, as far as possible, in the direction from the east, westwardly.

The board, after mature deliberation and carefully weighing all the considerations discussed in this report, respectfully submits as its project for the commencing of the proposed breakwater, the following, viz:

To commence an easterly section of the work at a point on the line of the project of the board of 1870, where that line is cut by a line drawn northwest (true) from the lake end of the present light-house pier extension; to build thence westwardly until the shore end of the project is attained. Should it become apparent at any time that an eastward extension within the limits of the project of the board of 1870 is necessary for the commerce of the port, or protection of existing works, such a section may be built. With these conclusions the board respectfully reincloses, herewith appended, the papers furnished from the office of the Chief of Engineers for its consideration, and have the honor to be, very respectfully,

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
F. HARWOOD,
Captain of Engineers.

I dissent from the forogoing report, and will present my views in a separate memoir.
Very respectfully,

JOHN M. WILSON,
Major of Engineers.

The CHIEF OF ENGINEERS, *U. S. A.*

[Special Orders No. 42.—Extract.]

A. HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., April 10, 1871.

1. A board of engineer officers, to consist of Lieutenant Colonel I. C. Woodruff, Major J. M. Wilson, and Captain Franklin Harwood, will assemble in Oswego, New York, on the 12th instant, or as soon thereafter as practicable, to consider and report upon a question in connection with the preservation of the work of improvement at the harbor of Oswego, to be submitted by letter of instruction from this office.

* * * * * * * * *

By command of Brigadier General Humphreys:

THOMAS LINCOLN CASEY,
Major of Engineers.

B. OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., April 10, 1871.

COLONEL: Congress having appropriated for "enlargement, according to the plan of the Engineer Department, of harbor facilities at Oswego," and it being of the first importance that the appropriation shall be applied so that the greatest benefit to commerce and protection to existing works may be derived from the expenditure, the question arises as to the point of commencing work in the line of proposed pier and breakwater, whether at the shore end, the eastern, or at some intermediate point, say at the point of the proposed breakwater nearest the 12-foot curve, about 3,000 feet from the eastern end, (as indicated on the tracing accompanying report of board of engineers of March 30, 1870.)

The board will consider this question and report their views with a recommendation as to the proper point to commence the work.

In this connection the board is referred to the report of Colonel Bowen, of March 7, 1870; report of the board of engineers, of March 30, and accompanying drawings, (see Appendix Annual Report of Chief of Engineers, 1870;) the project of operations of Colonel Wilson, of March 18, 1871; the letter from this office of March 25, 1871, and Colonel Wilson's reply thereto of April 1, 1871.

Copies of these last three communications are inclosed, and Colonel Wilson will be instructed to lay before the board the above-mentioned drawings, and such other information and papers as the board may desire.

By command of Brigadier General Humphreys.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Major of Engineers.

Lieutenant Colonel I. C. WOODRUFF,
Corps of Engineers, P. O. Box 4032, *New York City.*

UNITED STATES ENGINEER OFFICE,
Oswego, N. Y., March 18, 1871.

GENERAL: In reply to your communication of the 16th instant, I have the honor to submit the following project for the prosecution of the work in the harbor of Oswego, New York.

There is now available from former appropriations about $26,000, which, with the new appropriation, makes the amount to be expended from the present time up to June 30, 1872, $126,000. With this I propose to commence the breakwater for the new harbor, according to the plan recommended by the board of engineers, and approved by the Chief of Engineers.

I will commence at the shore end of the west arm of the breakwater, and hope during this season to complete about seven hundred feet of it, at a cost of about $73,500; with the remaining $52,500 I expect to complete 300 feet more during the coming spring, thus giving the contractors an opportunity to procure a portion of the necessary materials during the winter.

The plan, if approved by the Chief of Engineers, will therefore be as follows:

To construct this season, commencing at the shore end of the west arm, 700 feet, at $105 per foot	$73,500 00
In the coming spring to continue this line 200 feet turn the angle and go 100 feet in the new direction; total distance in the spring 300 feet, at $175 per foot	52,500 00
	126,000 00

The work will be done by contract after advertising, and complying with existing laws and regulations.

An estimate will be submitted at a later day for repair of the old pier, for which it is presumed the present appropriations are not available.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Major of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., March 25, 1871.

MAJOR: Referring to your project of March 18, for the prosecution of the work on the new breakwater at Oswego, you will please give your reasons for recommending that the work be commenced at the shore end instead of on the breakwater proper, viz, at the eastern end, or about the middle of the main work.

Will not the harbor protection given in the latter case be much sooner gained and more extended than if built as proposed, and will not the protection which the old harbor works need be more effectual by beginning at or near the east end than if the work were commenced at the shore end?

By command of Brigadier General Humphreys.

Very respectfully, your obedient servant,

JOHN G. PARKE,
Major of Engineers.

Major J. M. WILSON,
Corps of Engineers, Oswego, New York.

UNITED STATES ENGINEER OFFICE,
Oswego, New York, April 1, 1871.

GENERAL: On returning from an inspection of the forts and harbors under my charge this morning, I found your letter of the 25th ultimo, asking for my reasons for recommending that the work on the new breakwater at Oswego be commenced at the shore end instead of on the breakwater proper, viz, at the eastern end or about the middle of the main work.

I have the honor to report as follows: The eastern end is located in water 20 feet deep and opposite the end of the present breakwater; a crib sunk here would be an obstacle against which vessels entering the harbor at night might strike, and during a storm it would be impossible to place a light upon it, and one single shipwreck would create a disturbance that it would take years to quiet. Moreover, the water at this point is over 20 feet deep, and although it will be very easy to locate the point with a buoy, difficulties will arise in sinking the crib at the proper spot, as it will weigh about 150 tons, and be acted upon by the current both of the lake and river. Again, as the water is the deepest along this portion, but a small show could be made with the amount of money on hand; not more than 500 feet could be completed, and as the prevailing wind here is from the northwest, which rolls the sea from the west along the shore, but little if any benefit would be derived from this length; as a protection for the old pier 2,000 feet would have to be completed, and even then, until the shore arm was built, the sea would roll in from the west and render the harbor dangerous. Again, the cribs will have to be constructed in the present harbor at first; the water here is not deep enough to construct a crib for a depth of 20 feet unless we work in the portion demanded for commerce.

The same objections exist in my mind to the commencement at the middle of the breakwater.

The advantages gained by commencing at the shore end are as follows:

The cribs can be constructed in the old harbor and towed around; the shore end can be firmly bolted to the rocks, which run out some distance, thus giving a strong anchorage to which the other cribs can be connected by the superstructure, and as soon as the angle is turned a small harbor is already completed, which will increase in size as we continue the breakwater. Moreover, with the present appropriation we can build about one thousand feet, and make a much greater show with the money at our command, a point which, although the Chief of Engineers may deem unworthy of consideration, I think of the utmost importance, from the fact that if the citizens can be satisfied, and at the same time the interests of the Government properly carried out, the Department will be saved a great deal of annoyance.

I do not think that the harbor protection given by commencing at the middle or eastern end will be greater than if built from the shore end, as heavy seas will roll in from the west; the shock will, however, be broken to a great extent, but will still be severe; the same is true as regards the protection of the present pier.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Major Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS, *U. S. A.*

OSWEGO, NEW YORK, *April* 17, 1871.

GENERAL: Differing in opinion from the report presented by the board of engineers convened in this city by Special Orders No. 42, Headquarters Corps of Engineers, United States Army, to consider the point at which the work on the new breakwater should commence, I have the honor to present my views upon the subject.

The points to be considered, as submitted by the Chief of Engineers, are as follows: Shall the work commence at the shore end, at the eastern end, or at some intermediate point, say nearest the 12-foot curve, in order that the greatest benefit may be derived to commerce, and to protection of existing works?

Two questions arise here which should, I think, be treated separately; one in reference to the greatest benefit to commerce, the other to protection of existing works.

The board summarily disposes of my original recommendation to commence at the shore end by stating that it would form an isolated harbor a mile away from the present one, and with no communication in stormy weather; they also state that the greatest benefit to commerce and protection to existing works will be gained by commencing at a point about 300 feet from the eastern end, as projected, and working to the westward, but that to protect existing works would require a section of the breakwater from 1,500 to 2,000 feet long to be constructed, which could not be built in less than three years, supposing liberal appropriations to be made; they state at the same time that this would give a convenient and accessible anchorage for vessels putting in under stress of weather.

I agree with the board in one point, namely, that no adequate protection for the existing works can be gained short of building 1,500 feet of breakwater, and that this could not be completed in less than three years; on all other points I beg to dissent, and to give my own views as follows:

Should work be carried on as recommended by the board, within three years a breakwater about 1,500 feet long could probably be built, every circumstance being favorable, at a cost of about $350,000, as the depth here at ordinary low water varies from 20 to 25 feet, and is the deepest portion of the line except at one place; the object gained by this, the board states, would be the protection of the present work and an *anchorage for vessels driven in by stress of weather.*

I acknowledge that protection for the present work will be gained by this, but believe that within three years the old work thus protected will require almost entire rebuilding, and that about the same amount of repairs will be required during that time wherever the new breakwater is commenced.

I do not believe that an available anchorage in stormy weather will be obtained here. In the discussion before the board allusion was constantly made to the harbor of Buffalo; the two cases are not similar; at that place there is no shore arm contemplated, and moreover I understand that the wave strikes the breakwater at right angles; here it strikes it at an angle of about 45°, and the heavy sea will roll in through any opening left to the westward. I fully agree that the desired end is being carried out, and that the completion of the harbor is being forwarded, but think that the most expensive work will be done, and the least results attained, as, except to protect existing works, but comparatively little direct benefit to commerce will be extended until the shore arm is completed. Any vessel seeking this harbor in stress of weather would run right into the present one, and not remain outside in a position in which the wind and sea would be liable to make her drag her anchors and carry her on shore.

It is my opinion that if the shore arm is first constructed it will receive the full shock of the waves coming from the west, and that when the angle is turned, harbor room, although nearly a mile distant from the mouth of the Oswego River, will be at once gained, and will continue to increase as the outer breakwater is lengthened, and that in the same length of time, and with the same amount of funds as indicated by the board for 1,500 feet of breakwater, I can, by commencing at the shore end, build a safe harbor at least 30 acres in extent, 20 acres of which will be outside of the 12-foot curve.

More harbor and dock room is what is wanted here, and as soon as the angle is turned new docks will probably be built and accommodations given for the great lumber trade with Canada.

My predecessor, Major Bowen, intended commencing at the angle and working in both directions, and had a crib constructed and ready to sink there when he was relieved in November; his successor, Lieutenant Greene, would not sink it, as he differed as to the point of beginning, and wanted to commence on shore; I was not aware of his opinion, however, until after I had formed my own.

In conclusion, I therefore respectfully submit that I believe that the greatest benefit to commerce will be gained by commencing at the shore end, and while agreeing with the board that the present old work will be more quickly protected by commencing at the point indicated, near the east end, still think that the amount of repairs necessary to save it during the next three years, will be nearly the same wherever the work is commenced.

I am, general, very respectfully, your obedient servant,

JOHN M. WILSON,
Major of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

F 9.

REPORT OF OPERATIONS IN THE HARBOR OF OGDENSBURGH, NEW YORK.

Operations were commenced July 30, 1870, under an agreement with Cornelius Daly, of Ogdensburgh, whereby his dredge, scows, and tug were hired by the United States for the sum of $60 per day. The dredge was at once placed in the channel of the Oswegatchie River, and the excavation there completed to a depth of 12 feet at low water, with the exception of the removal of a large boulder, by the 28th of September: during this period 2,952$\frac{1}{3}$ cubic yards of material were removed, consisting of an aggregation of small boulders, cobble-stones, sand and gravel, closely knit together. On the 28th of September, under the same agreement, Mr. Daly's dredge was placed on the channel in the St. Lawrence River, which is to be 150 feet wide, and the inner line 25 feet from and parallel to the line of the city docks.

Operations were continued in this channel until the close of navigation, December 23, 1870, during which time 8,814 cubic yards were removed, the material being similar to that found in the Oswegatchie River.

On the 15th of February, 1871, proposals were invited for dredging the channel in the St. Lawrence, and on the 21st of March the work was awarded to Mr. Cornelius Daly, the lowest bidder, at 19 cents per cubic yard, measured in scows. Mr. Daly commenced work with two dredges on the 12th of April; one dredge was placed at work in the St. Lawrence channel, removing the quantities of sawdust, shavings, and mud that had accumulated over the harder material underneath, for which it was intended to invite proposals afterward; the other dredge commenced just east of the Prescott ferry dock, and dug within the limits indicated to the depth of 12 feet at mean low water. The contract with Mr. Daly was closed June 30, 1871, he having removed 57,437$\frac{81}{100}$ cubic yards during the season.

While the dredges were at work, I observed large quantities of sawdust and shavings were removed, and I found that the saw-mills on the Oswegatchie were in the habit of depositing their refuse into the river. The city council had passed an ordinance prohibiting such deposits, and hearing that an attempt was being made to have it repealed, I addressed a letter to the mayor of the city upon the subject; no reply was received.

Shortly after, at the request of the committee on the harbor and wharves of the city, I wrote to them upon the subject; the receipt of my letter was courteously acknowledged; a copy of it marked (A) is appended.

On the 12th of June proposals were invited for removing the boulder in the Oswegatchie, dredging that portion of the St. Lawrence channel in which the hard bottom occurs, and a portion of the remainder; it is proposed to award the boulder and the hard bottom section as entire jobs; the rest will be awarded by the cubic yard, measured in position.

During this season it is proposed to remove the boulder in the Oswegatchie, and to dredge to a depth of 12 feet at low water such portions of the channel in the St. Lawrence as the means at hand will allow.

Ogdensburgh is a port of entry in the collection district of the Oswegatchie; there is a fixed white light of the fourth order near the entrance to the harbor.

Forts Ontario and Montgomery are each one hundred and twenty miles distant; the one to the southwest, the other to the east.

The amount of revenue collected here during the fiscal year was $329,466 98. The value of the imports was $1,712,968. The number of vessels entering was 928, with an aggregate tonnage of 222,551 tons. The number of vessels clearing was 965, with an aggregate tonnage of 232,609 tons.

Abstracts of proposals, with names of bidders, and abstracts of contracts are transmitted herewith.

Amount available July 11, 1870	$20,394 89
Amount expended during year	20,394 89
Amount appropriated for fiscal year ending June 30, 1872, available July 1, 1871	25,000 00
Amount required for the fiscal year ending June 30, 1873, to complete the dredging	10,000 00

A.

UNITED STATES ENGINEER OFFICE, *Oswego, New York, June* 6, 1871.

GENTLEMEN: In reply to your request, communicated through Mr. Chapin, I have the honor to state that, in my opinion, the local authorities of your city should at once take prompt and energetic steps to prevent sawdust, shavings, and other refuse from being thrown into your harbor.

The Government of the United States is annually expending large sums for your benefit, and a great deal of this money has been used in removing sawdust, shavings, &c., that have accumulated in years past. It is hardly necessary to give any scientific reasoning on this subject; the facts show for themselves.

The shavings and sawdust deposited in the Oswegatchie River soon become thoroughly saturated with water, which increases their specific gravity to such an extent that they naturally sink; but the velocity of the Oswegatchie is such that this material is carried onward until it reaches the mouth of the river; here the water is no longer confined within the narrow limits of the Oswegatchie; it expands over a large surface; its velocity is decreased accordingly, and the sawdust, shavings, &c., thus far carried along, sink to the bottom and fill up the channel.

I have already called the attention of his honor the mayor to this subject, and trust that the local authorities will take prompt and effective measures to remedy this evil.

I am, gentlemen, with great respect, your obedient servant,

JOHN M. WILSON,
Major Engineers, U. S. A.

To the honorable COMMITTEE ON WHARVES AND HARBOR,
Common Council of Ogdensburgh, New York.

Abstract of bids for dredging in the harbor of Ogdensburgh, New York, advertised February 15, 1871; opened at Oswego, New York, at 12 m., March 21, 1871, by John M. Wilson, Major Corps of Engineers.

No.	Names of bidders.	Residence.	Price per cubic yard.	Quantity bid for, cubic yards.
1	Cornelius Daly	Ogdensburgh, N. Y	$0 19	*50,000
2	William S. Malcolm	Oswego, N. Y	22	*50,000
3	Alanson Dodge	Fulton, N. Y	31	*50,000
4	C. P. Morse & Co†	Oswego, N. Y	‡22¾ §16¾	*50,000
5	E. H. French	Fulton N. Y	27½	*50,000
6	E. R. Seward	Albany, N. Y	26½	*50,000

* More or less. † Informal; not in accordance with advertisement. ‡ Blue clay. § Gravel and mud.

Abstract of contracts for Ogdensburgh Harbor, N. Y., during fiscal year ending June 30, 1871.

No.	Name of contractor.	Residence.	Date of contract.	Subject of contract.	Price per cubic yard.	Remarks.
1	Cornelius Daly	Ogdensburgh, N. Y	March 25, 1871	Dredging	19 cents	Closed June 30, 1871.

F 10.

REPORT OF OPERATIONS AT SALMON RIVER, LAKE ONTARIO, NEW YORK.

An examination and survey was made at this place in August, 1870, in accordance with the act of July 11, 1870, for the purpose of ascertaining what harbor improvements were necessary.

A report and map were transmitted by Lieutenant B. D. Greene, Corps of Engineers, on January 7, 1871, showing the work to be done and the cost thereof.

It is deemed necessary, in order to render this an available harbor, that two piers should be constructed; one 625 feet long, the other 1,350 feet long, extending into the lake; that 50,000 cubic yards of earth should be removed by dredging, and 820 linear feet of pier, to protect the channel dredged, should be constructed. The total cost is estimated at $112,741 40.

There seems to be no urgent necessity for a harbor of refuge at this place, Oswego and Sackett's Harbor being within reasonable distances.

This harbor is situated within the Oswego collection district, and is a port of entry. The nearest port is Ontario, and the nearest light at Oswego; there is a light-house here, but no light kept up.

The amount of revenue collected during the last fiscal year was $1,500. The value of the imports, $18,000, and the aggregate tonnage of vessels entering and clearing, 5,500 tons.

The appropriation under which this survey was made was: "Examination and survey on northern and northwestern lakes and rivers, and the Atlantic and Pacific coasts."

Amount expended during the year	$253 88
On hand July 1, 1871	1,746 12

All of which reports of operations upon the works on Lake Ontario are respectfully submitted.

JOHN M. WILSON,
Major Engineers, U. S. A.

F 11.

UNITED STATES ENGINEER OFFICE,
Oswego, New York, January 7, 1871.

GENERAL: The following report, to accompany the map of the mouth of Salmon River, Lake Ontario, sent to the Department on the 27th ultimo, is respectfully submitted:

The village of Port Ontario, from which the port of entry derives its name, is situated upon the west bank of Salmon River, about a mile from its mouth. It consists of one store-house, one store, one tavern, and six houses. Its only business is the receipt of a small quantity of lumber, (ties and posts.)

The river below Port Ontario, excepting immediately at its mouth, is of sufficent depth, with a small amount of dredging, to admit vessels of any class.

The village named Selkirk, at the mouth of the river, and upon its east bank, consists of a tavern and three houses, including the old light-house. This village has no business whatever, in fact, beyond the result of the natural process of decay. I think no change can be reported in either village since Colonel Blunt's report of 1867, or even Lieutenant Smead's, of 1836.

Salmon River is of considerable magnitude for many miles above its mouth, and flows through a heavily timbered section of country; most of its timber, however, is shipped by the railroad, which crosses it near Pulaski, five miles from its mouth.

The crib-work of the old piers is still in good condition, and the top of it some three feet under water. The bar which has formed at the mouth, or rather about 800 feet in front of the mouth of the creek, will admit nothing drawing over 6 feet of water, and even for such the channel is narrow and crooked, although in all probability sufficient for the villages with which it has to do.

It scarcely seems reasonable that there is any urgent necessity for a harbor of refuge here, although two vessels were lost here last fall. A light kept here to warn vessels away would certainly be of advantage.

Mexico Bay, as the angle at the eastern end of Lake Ontario is called, is a dangerous place for vessels in a storm; a light which would lead them to avoid it would save many, while, on the other hand, a harbor would save many of those which might unavoidably be driven into the bay.

The old crib-work would furnish a good foundation for piers, and could be built up at slight expense. But for sailing-vessels the piers do not seem to be properly located, and, besides, the cost of dredging would be very great. The plan proposed by Colonel Blunt seems preferable, with the modification that Selkirk Pond should not be dredged.

This would very materially reduce his estimate of the cost. What few people there are there, desire only some improvement which shall enable them to bring a vessel into and up the river.

The river as it is furnishes room enough for a harbor of refuge for the few vessels that may be compelled to enter it; the great need is an opening into the lake.

Colonel Blunt in his estimate does not allow for dredging a bed for the piers. It is probable that he intended to place them on the bottom of the lake; this would require leaving a slope on either side the dredged channel, from the bottom of the channel up to the bottom of the cribs. As the shore is approached, then the channel would be more contracted, considerably more. The direction of the channel is about northwest;

this is favorable for vessels entering in very heavy weather, but the sea, as well, will roll in, and on account of the contraction of the channelway, will be much heavier 1,000 feet inside the piers than at the entrance. The bottom is said to be a hard clay, under the sand. To dredge for the piers would increase the cost of the improvement very considerably. It might perhaps be avoided by changing the direction of the piers slightly, as indicated in the partial tracing inclosed. This would increase the cost of the piers very little, if any; they can be placed on the natural bottom of the lake, and a channel 200 feet wide dredged between them.

The sea rolling in from the west will be spread out and lose its force. The direction of the shore is nearly north and south. Even where the shore is east and west, and the piers run north and south, the sea from the west, although the west pier tends to shelter the channel, often draws around and causes damage to vessels entering. It seems to me that in this case, two oblique piers might answer the purpose better than two parallel ones.

The following statistics exhibit the commerce of Port Ontario for the calender year of 1870:

Clearances.—Foreign, 76; coastwise, 12.

Entries.—Foreign, 75; coastwise, 12.

Value of imports, $15,800; revenues collected, $1,346.

As the present prices reduce Colonel Blunt's estimate considerably, I submit a new one for the piers. The cost of excavation would be now about as stated in Colonel Blunt's estimate.

Estimate of cost of dredging and pier-work, for improvement of mouth of Salmon River, New York.

Cut through spit above low water at narrowest point, called "Wind Gap," 11,713 cubic yards excavation, at 30 cents per yard	$3,513 90
Channel through spit 200 feet wide, with 12 feet water, 27,821 cubic yards dredging, at 25 cents per yard	6,955 25
Twenty feet additional width for retaining-piers, 2,779 cubic yards dredging, at 25 cents per yard	694 75
Dredging outside and between piers, 1,300 feet long, 200 feet wide, 6 feet average depth, 57,770 cubic yards, at 25 cents per yard	14,442 50
Retaining-piers to protect sides of cut, 820 linear feet, at $23 per linear foot	18,860 00
Two wings connected with outer piers, 325 linear feet, at $7 per linear foot	2,275 00
North pier, 625 linear feet, at $30 per linear foot	18,750 00
South pier, 1,350 linear feet, at $35 per linear foot	47,250 00
Total cost of improvement	112,741 40

Respectfully submitted.

BENJ. D. GREENE,
Lieutenant United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

APPENDIX G 1.

UNITED STATES ENGINEER OFFICE,
HOUSTON AND GREENE STREETS,
New York, September 16, 1871.

GENERAL: I have the honor to submit the following report of operations on the improvement of Plattsburgh harbor, New York, and Burlington Harbor, Vermont, during the year ending June 30, 1871.

On September 23, 1870, advertisements were issued for proposals for extending the breakwater in a northeasterly direction for a distance of about 90 feet. Abstract of bids received is transmitted herewith.

The extension, which is in one crib 94 feet in length and 25 feet in width, was commenced in January, and in February was sunk in its proper position and filled with stone; the work on the superstructure is to be completed during the present season.

Under the appropriation for this harbor passed March 3, 1871, advertisements were issued for a still further extension of the breakwater in a northeasterly direction for a distance of about 140 feet. Abstract of bids received is transmitted herewith.

The extension, which is in one crib 150 feet in length and 25 feet in width, was commenced in June and carried up to a height of about 7 feet.

This crib is to be completed, sunk, and filled with stone by December 30, 1871, and left to settle until the following season, when the superstructure is to be constructed and filled with stone to a height of 9 feet above the level of average low water.

To complete the improvements at this harbor the following work should be undertaken:

ESTIMATE.

156 feet of breakwater, at $90	$14,040 00
Revetment of beach	7,000 00
Dredging	16,000 00
Contingencies	2,000 00
	39,040 00

I respectfully recommend that an appropriation of $23,000, necessary to complete the breakwater and build a revetment of the beach and for contingencies belonging to the same, be made at the next session of Congress. The completion of the breakwater should not be delayed, while the protection of the beach is immediately necessary to prevent the erosion of the beach, and a call for additional amounts to dredge the harbor.

Abstract of bids received in answer to advertisement of September 23, 1870, for extension of breakwater at Plattsburgh, New York.

No.	Names of bidders.	Crib complete and sunk in position.	For superstructure.
1	E. R. Seward	$85 per linear foot	$25 per linear foot.
2	Luther Whitney	$68 per linear foot	$22 per linear foot.

Abstract of bids received in answer to advertisement of April 17, 1871, for extension of the breakwater at Plattsburgh, New York.

No.	Names of bidders.	Crib complete and sunk in position.	Superstructure.	Total.
1	Jon. P. Hagar	$67 per linear foot	$35 per linear foot	$102 00
2	Luther Whitney	$63 per linear foot	$21 per linear foot	84 00
3	Samuel G. Hart	$80 per linear foot	$20 per linear foot	100 00

JOHN NEWTON,
Lieutenant Colonel Engineers, Brevet Major General.

G 2.

REPORT OF OPERATIONS ON THE IMPROVEMENT OF BURLINGTON HARBOR, VERMONT.

On August 18, 1870, advertisements were issued for proposals for extending the breakwater in a northerly direction for a distance of 175 feet. Abstract of bids received is transmitted herewith.

The extension is in two cribs, one 80 feet in length and one 91 feet in length, each 30 feet in width; these cribs were both completed, sunk, and filled with stone by December 31, 1870; the work on the superstructure is to be completed during the present season.

Under appropriation for this harbor, passed March 3, 1871, advertisements were issued for an extension of the breakwater in a southerly direction for a distance of about 200 feet. Abstract of bids received is transmitted herewith.

The extension, which is to be in two cribs, will be 217 feet in length, and 30 feet in width, and was commenced in the month of June, but at the close of the year no definite progress had been made. These cribs are to be completed and filled with stone by December 30, 1871, and left to settle until the following season, when the superstructure is to be constructed and filled with stone to a height of 9 feet above the level of average low water.

Of the extension of the breakwater in a northerly direction, as recommended by a special board of engineers, June, 1867, there remains to be constructed a length of 669 feet. In the mean time, however, the wharves have developed so far to the southward that the call for an extension of breakwater in that direction appears to be more urgent than in the other—though both are necessary.

I cannot transmit with this report the map of Burlington Harbor, made by the lake survey under Major Comstock, having sent my copy to the superintendent at Burlington to have certain lines concerning this breakwater marked thereon.

The question as to the application of succeeding appropriations to the extension in either direction will be submitted in time to the Chief of Engineers for his action.

In view of the large extension of breakwater needed in both directions, I respectfully recommend an appropriation of $60,000 for this work. This amount would suffice for the construction of about 450 feet of breakwater.

Abstract of bids received in answer to advertisements of April 17, 1871, for extension of the breakwater at Burlington, Vermont.

No.	Name of bidder.	Crib complete and sunk in position.	Superstructure.	Total.
1	Luther Whitney	$96 per linear foot	$23 per linear foot	$119
2	Samuel G. Hart	$110 per linear foot	$25 per linear foot	$135

Abstract of proposals received in answer to advertisement of August 18, 1870, for the extension of the breakwater at Burlington, Vermont, opened at 12 o'clock, noon, on September 5, 1870.

Bidders.	For crib complete sunk in position and filled with stone.	For superstructure complete, filled with stone.
E. R. Seward	$135 00 per linear foot	$45 00 per linear foot.
Luther Whitney	$110 81 per linear foot	$22 16 per linear foot.
A. Chapman	$121 57 per linear foot	$37 30 per linear foot.
O. J. Jennings	$111 50 per linear foot	$27 00 per linear foot.
Charles J. Degraw	$9 70 per linear foot	$4 70 per linear foot.

Respectfully submitted.

JOHN NEWTON,
Lieutenant Colonel of Engineers, Brevet Major General.

APPENDIX H 1.

ROCK ISLAND, ILLINOIS,
September 7, 1871.

GENERAL: In submitting to you the annual reports of my assistants, in local charge of the several works intrusted to my general supervision, I beg leave to offer the following remarks:

ROCK ISLAND BRIDGE.

By the joint resolution in relation to the Rock Island bridge, approved on 20th July, 1868, it was provided that the expenditure (for said bridge) on the part of the United States should not exceed the sum of $1,000,000, and by several acts appropriating and re-appropriating money, the sum named in this limitation has been granted for this great work.

Of this fund there was in my hands on 1st July, 1870	$26,026 88
During the fiscal year ending June 30, 1871, I received	302,500 00
Making in all	328,526 88
Of which I have expended during the fiscal year, chiefly for the substructure	169,748 60
Leaving on hand 1st July, 1871	158,778 28
In addition to which I believe that there is available in the Treasury for this work about	577,500 00
In all	736,278 28

the larger portion of which has been pledged in contracts for the work, or authorized to be so pledged. There can be no doubt of its sufficiency for the completion of the bridge. The accompanying report, (marked A,) from Captain A. Stickney, in charge of the substructure, shows the state of the work at the end of the fiscal year. The only unfinished pier will be completed in ample time for the superstructure.

The contractors for the superstructure, having met with unexpected delays in the manufacture of the iron-work, applied for and received an extension of time for the completion of their contract for the first three spans of the bridge until 15th October, 1871. It is supposed that this will not materially delay the completion of the entire work, which they promise shall be done in the current fiscal year.

The report (marked A 1) of Captain W. H. H. Benyaurd, herewith submitted, gives a concise statement of the progress of the superstructure, of which he is the engineer in local charge. While the work during the fiscal year would seem to have been chiefly of a preparatory character, there will be but a short time required to set up the iron, which has been fabricated at different shops at a distance, and is now in course of delivery here, when the importance of this preparatory work will be manifest to all.

When this work shall have been completed, and all claims connected with it adjusted, it is proposed to give an exact statement, in minute detail, of its cost, and a full history of the bridge, from its inception.

PRESERVATION OF THE FALLS OF ST. ANTHONY.

Funds received during last fiscal year	$70,000 00
Expended ($21,661 42 of which applied to the apron)	61,425 83
On hand 1st July, 1871	8,574 17
Remaining in the Treasury on 1st July	30,000 00
Total available in current fiscal year	38,574 17

This, at the end of June, was thought to be sufficient for carrying out the plan of permanently closing the tunnel as far as the foot of Nicollet Island, as by report (marked B) of Mr. F. Cook, my assistant in local charge; but certain newly-discovered weak points were developed a few days after the close of the fiscal year, which caused a diversion of the labors of the working party, as set forth in the supplementary report, (marked C.) It is a fortunate circumstance that we had an organized force at hand to go to the rescue in the case of this new and unexpected irruption of the waters, and my assistant, Mr. Cook, deserves great credit for the promptness with which he put forth his well-directed efforts, and arrested the havoc arising from this new danger.

At the same time this evidence of a widely extending weakness in the natural barrier, (forming the falls,) demonstrates the insufficiency of former estimates for "the preservation of the Falls of St. Anthony," and it is only on getting the results of the survey, now in progress there, that new estimates can be presented.

IMPROVEMENT OF THE MINNESOTA RIVER.

This work was carried on under an agreement with Mr. Sanford A. Hooper, upon the terms of his contract of a former year, because there was not time for advertising anew without the risk of losing the favorable season for work; moreover, General Warren, my predecessor in charge of this work, pronounced this "a contract at very reasonable rates." It will be seen by the accompanying report (marked D) from Captain Edwin Bell, the United States inspector of this work, that during the year there were removed 743 snags and 848 cubic yards of boulders.

Amount received for this work	$10,000 00
Expended in last fiscal year	9,903 56
On hand 1st July, 1871	96 44
To which may be added the appropriation made on the 3d of March, 1871	10,000 00
Leaving available for current fiscal year	10,096 44

which will be applied to continuing the work under a new contract, which has been entered into with Mr. S. A. Hooper, on terms differing but little from those of his previous contract.

As the Minnesota River, above the south bend, must be, for some years to come, the main channel of communication for developing the region through which it flows, I would ask for a further appropriation for completing its improvement of fifteen thousand dollars.

IMPROVING ILLINOIS RIVER.

The work upon the Illinois River improvement is fully set forth in the accompanying report (marked E) from Mr. R. E. McMath, civil engineer, assistant in local charge of the operations, by which it will be seen that the contract with F. D. Van Wagenen for work in the upper part of the river was nearly completed at a cost of some $80,843 59, of which there was paid by me $34,755 48, the larger part having been paid by my predecessor, (see my exhibit of expenditures under head of "Repair, preservation, &c.," herewith.)

Under the contract with J. T. Hayden, for work upon the lower portion of the river, there has been paid for engineering and office expenses	$11,763 75
And for work done by contractor	14,506 35
	26,270 10
Leaving available to be applied to continuing this work the sum of	63,729 90

which will be required for the contract now in course of execution.

The assistant in charge presents an estimate for the completion of the work in accordance with the present plans, amounting to the sum of $292,000; of which $150,000 could be expended profitably during the coming fiscal year. In this I agree with him, and would respectfully ask for an appropriation for the fiscal year ending 30th June, 1873, the sum of $150,000 for continuing the improvement of the Illinois River.

DES MOINES RAPIDS OF THE MISSISSIPPI RIVER.

This work has been pushed forward with commendable zeal, as set forth in the accompanying report (marked F) of Captain A. H. Burnham, Corps of Engineers, the assistant in local charge of the operations. To this report of the resident engineer I am compelled to refer for all details concerning the last year's operations.

It will be seen by it that his estimate for the completion of this great work is $1,000,000, and I agree with him in the opinion that if the amount can be granted in one appropriation, at an early day, it will conduce greatly to economy in the execution of the work remaining to be done.

I have received for this work during the year from the various appropriations heretofore made for it the gross sum of	$494,979 70
And expended during the fiscal year	605,923 76
Leaving on the 1st of July due from the United States	110,944 06
At the same time there was in the Treasury available for this work, in all	400,000 00
Showing a remainder still applicable on the 1st of July, 1871	289,055 94

which will be absorbed in the present season in payment of section-work, lock-work, and contingencies, in fulfillment of existing contracts.

I would ask for an appropriation for the completion of this improvement, in accordance with Captain Burnham's estimate, the sum of $1,000,000.

ROCK ISLAND RAPIDS.

The report (marked G) of Major E. F. Hoffman, civil engineer, assistant in local charge, gives a history of the work for the past year, by which it will be seen that, from circumstances beyond our control, much less work than usual has been accomplished during the year. Whilst we have lost by death the contractor to whom the work was awarded in the past season, there is reason to believe that from the zeal and activity displayed by the present contractor in the last contract in which he was engaged with us, there will be no time lost in the completion of this work; also, that the Government has made more favorable terms in the new contract than in that which was canceled.

Cash received for this work during the year from the appropriation of 25th July, 1868	$3,597 28
From the appropriation of 11th July, 1870	27,000 00
	30,597 28
Expended during the fiscal year	12,586 84
Leaving on hand 1st July, 1871	18,010 44
To which should be added the amount available in the Treasury of about	253,000 00
Making a total available of	271,010 44

which will be applied to continuing the work during the current fiscal year according to the project submitted to you on the 7th April, 1871, for perfecting this improvement, and meeting all probable contingencies in closing up this work, such as clearing out all patches of rock between the places already improved, &c. I would ask for an appropriation of one hundred thousand dollars for the fiscal year ending 30th June, 1873, ($100,000,) for improvement of Rock Island Rapids.

UPPER MISSISSIPPI RIVER IMPROVEMENT.

This work was in the local charge of United States civil engineer, H. C. Long, up to the time of his death. He had just gone to La Crosse, with a view of making preparations for the season's work, when he died, on the night of the 10th of April, 1871. He had continued in the field during the season of 1870, until about 11th of November, when it became necessary to lay up for the winter the boats employed upon this service.

During the season of 1870, good service was rendered by the steamers. The Caffrey, being the smaller of our two boats, was employed on that part of the river between St. Paul and Lake Pepin, and the Montana was employed below the lake. In the present season the boats were assigned to the same districts, and worked with good effect until the river fell to such an unusually low stage as to prevent the Caffrey from working above Prescott.

Since this work of scraping the bars of the Upper Mississippi River was begun, some four years since, by my predecessor, we have not had such low water in the Mississippi as during the present season; still the work has been carried on with useful results in such parts of the river as our boats could reach. The necessity of having boats built of light draught expressly for this duty is made more manifest than ever by the low water which has this season impeded our work at the time when our assistance was most needed. I therefore trust that there may be an appropriation made to enable me to build at least one boat of light draught, for working as far up the river as St. Paul at the lowest known stage of water.

During the fiscal year ending 30th June, 1871, I received for this work	$31,000 00
And at the commencement of the fiscal year I had on hand applicable to it from the appropriation for "Repairs, preservation," &c., approved July 25, 1868	3,449 19
	34,449 19
Expended during the year	36,385 05
Leaving due from United States on 1st July, 1871	1,935 86
To meet which there was in the Treasury, at that date, available for this work	47,000 00
Leaving for expenses of the current fiscal year the sum of	45,064 14

the greater part of which will be required for the current expenses of these operations in the fiscal year ending on 30th June, 1872.

For the fiscal year ending on the 30th June, 1873, I would submit the following estimate:

For a steamer to work at scraping bars in shoal water	$30,000 00
For equipping two steamers for the season, say 7 months, at $6,000 a month	42,000 00
Total for improvement of Upper Mississippi River	72,000 00

REPAIR, PRESERVATION, EXTENSION, AND COMPLETION OF CERTAIN PUBLIC WORKS.

Of the above-named appropriation, approved on the 25th July, 1868, I had on the 1st July, 1870, the sum of	$4,863 24
And received during the fiscal year ending June 30th, 1871	179,295 31
Making to be accounted for	184,158 55

Of which I have expended during the fiscal year for the extension, &c., of works to which this fund was allotted, the sum of $165,781 65, as follows:

Improvement of Upper Mississippi River	$3,449 19
Improvement of Des Moines Rapids	123,979 70

Improvement of Rock Island Rapids	$3,597 28	
Improvement of Illinois River	34,755 48	
Total, as above stated		$165,781 65
Leaving in my hands on 1st July, 1871		18,376 90

to be applied to closing up old work carried on under this appropriation on above-named improvements.

Of the appropriation approved 11th July, 1870, for "Examination and surveys, for improvements on the north and northwestern rivers," &c., I received during the fiscal year ending June 30, 1871, $12,000 00

Of which I expended during the fiscal year the following sums:

For survey of ship canal from Henepin, Illinois, to Mississippi River, the report upon which I transmitted to you on 15th May, 1871	$7,389 93	
Examination Upper Mississippi River, improvement between Falls of St. Anthony and mouth of Minnesota River	147 45	
Examination and survey in Minnesota River	250 00	
Repairing surveying-boat	238 87	
		8,026 25
Leaving in my hands on 1st July, 1871		3,973 75

which, having been reappropriated by the act of 3d March, 1871, for the fiscal year ending 30th June, 1872, will be applied to such surveys as may become necessary in the field in my charge, one being now in progress above the Falls of St. Anthony.

For necessary surveys, in connection with the works of improvement under my care, I would respectfully ask for an appropriation for the fiscal year ending 30th June, 1873, for the sum of $7,500.

I submit herewith a tabular statement of funds showing amounts received, expended, and available, also amounts required for fiscal year ending 30th June, 1873.

All of which is respectfully submitted, by your most obedient servant,

J. N. MACOMB,
Colonel Engineers, United States Army,
General Superintendent U. S. Improvements.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Statement of funds for the fiscal year ending the 30th of June, 1871, *in connection with the works under the general superintendence of Colonel J. N. Macomb, Corps of Engineers, United States Army, showing the amounts on hand at the commencement of the fiscal year, (July* 1, 1870,) *the amounts received and expended during the same time, also the amounts available for continuing the works, and the amount required to be appropriated for the fiscal year ending 30th of June,* 1873.

	Repair, preservation, &c., of river and harbor works.	Examination and surveys on western and northwestern rivers.	Rock Island bridge.	Preservation of the Falls of Saint Anthony, &c.	Improving Upper Mississippi River.	Improving Minnesota River.	Improving Illinois River.	Improving Des Moines Rapids.	Improving Rock Island and Rapids.	Total.
On hand July 1, 1870	$4,863 24		$26,026 88							$30,890 12
Received during the fiscal year ending 30th June, 1871.	179,295 31	$12,000 00	302,500 00	$70,000 00	$31,000 00	$10,000 00	$52,000 00	$371,000 00	$27,000 00	1,054,795 31
	184,158 55	12,000 00	328,526 88	70,000 00	31,000 00	10,000 00	52,000 00	371,000 00	27,000 00	1,085,685 43
Amount expended during the fiscal year ending 30th June, 1871.	165,781 65	8,026 25	169,748 60	61,425 83	32,935 86	9,903 56	26,270 10	481,944 06	8,989 56	965,025 47
Due to the United States July 1, 1871	18,376 90	3,973 75	158,778 28	8,574 17		96 44	25,729 90		8,010 44	233,539 88
Due from the United States July 1, 1871					1,935 86			110,944 06		112,879 92
Due the United States										120,659 96
Balance of appropriations remaining in the Treasury July 1, 1871.			577,500 00	30,000 00	47,000 00	10,000 00	38,000 00	400,000 00	253,000 00	1,355,500 00
Amounts required to be appropriated for the fiscal year ending 30th June, 1873.		7,500 00			72,000 00	15,000 00	150,000 00	1,000,000 00	100,000 00	1,344,500 00

UNITED STATES ENGINEER OFFICE,
IMPROVEMENT OF THE DES MOINES RAPIDS,
Keokuk, Iowa, December 14, 1870.

GENERAL: I have the honor to inclose herewith a quarterly report, supplemental to my annual report, bringing the history of the works previously under my charge down to the date of my transferring the same to Colonel Macomb, accompanied by the following reports, and a tracing showing the state of the masonry at the lower lock of the canal for the improvement of the Des Moines Rapids; report of Captain A. H. Burnham, improvement of the Des Moines Rapids; report of Captain Charles J. Allen, improvement of the Rock Island Rapids; report of Civil Engineer Assistant Robert E. McMath, improvement of the Illinois River.

Very respectfully, your obedient servant,

J. H. WILSON,
Lieutenant Colonel and Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, December 9, 1870.

GENERAL: I have the honor to make the following report upon my transferring to Colonel Macomb the charge of the works on the improvement of the Des Moines Rapids, the improvement of the Rock Island Rapids, and the improvement of the Illinois River.

IMPROVEMENT OF THE DES MOINES RAPIDS.

The money appropriated for these works up to this time, amounting to $1,278,200, has now been nearly all expended on the locks, prism of the canal, and incidentals connected therewith. There remains to be excavated from the prism of the canal 147,414 cubic yards of earth, and 29,086 cubic yards of rock. In order to complete the embankment, it will be necessary to borrow (an easy matter) 76,052 cubic yards of earth, and 30,000 cubic yards of rock. The masonry of the lower lock is about half finished, but the excavation is nearly completed, while little more is required for the embankment. Nothing has been done for the guard or middle locks, or for Montrose Channel.

A careful computation has been made by Captain A. H. Burnham, of which the following is a summary, of the amount necessary for the entire completion of the work:

For section work	$341,180 90
For completing lower lock	131,170 52
For middle lock	119,273 54
For guard lock	328,635 62
For Montrose Channel	285,315 80
Amount necessary	1,205,576 38
Add 10 per cent. for contingencies	120,557 64
Total	1,326,134 02

This differs from the estimate submitted in my last annual report, as in that no estimate was made for Montrose Channel, and the quantities were taken from the original estimate. Changes in the character of the work, and especially in the prices bid, have also caused a difference, but it will be seen that the total amount varies but little from the original estimate, and is still within it.

For further information on the minutiæ of the work, I have the honor to invite your attention to the report of Captain A. H. Burnham, in local charge since August 1, 1870.

IMPROVEMENT OF THE ROCK ISLAND RAPIDS.

During the quarter ending September 30, 1870, operations upon this improvement have been confined to the removal of isolated patches and débris by the chisel-boats, and the removal of the obstructions caused by coffer-dams, which were laid at the commencement of the work. The engineer party, besides testing levels on each shore, have made 80,400 soundings, for the purpose of verifying the work done; these soundings are now being plotted by Lieutenant E. F. Hoffman, under whose immediate directions they were made.

For particular information, I have the honor to refer you to the report of Captain Charles J. Allen, Corps of Engineers, herein inclosed.

In pursuance of authority of the Bureau of Engineers, I caused an advertisement to be inserted in the leading newspapers, soliciting proposals for the continuance of work upon this improvement, and although the letting was made after my relinquishment of the supervision of the work, it is not out of place for me to mention that the lowest bid was submitted by Elliott Harroun, at the rate of $14 per cubic yard at Smith's Chain, and at $8 per yard for all the rest of the work. At these rates it will require $225,000, including 10 per cent. added for contingencies to complete the improvement. This sum should be appropriated without delay.

IMPROVEMENT OF THE ILLINOIS RIVER.

The work on the Illinois River, during the time which has elapsed since my last annual report, has been the excavation of 48,391.6 cubic yards of earth, taken from the channel at the bars, which caused the greatest trouble to navigation.

To complete the work, it is estimated that $250,000 will be required; this amount depends on the date of completion of the work, as more will be demanded if this date is after the close of the season of 1872.

Annexed will be found the report of Civil Engineer Assistant Robert E. McMath, (under whose immediate charge this improvement has been,) to which I have the honor to invite your attention.

As in the case of the improvement of the Rock Island Rapids, I advertised for bids for the continuance of this work. The lowest offered was by Messrs. J. T. Hayden & Co., of Chicago, at the rate of 24¾ cents per cubic yard.

SURVEY FOR A SHIP CANAL ROUTE FROM HENNEPIN, ILLINOIS, TO ROCK ISLAND.

In accordance with directions received from your office, dated July 23, 1870, I proceeded immediately to organize, equip, and send into the field a party for this survey. This party was placed under the charge of Civil Engineer Assistant H. A. Ulffers, to whom I gave instructions, of which the following is a copy:

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, September 5, 1870.

SIR: An allotment of $12,000 having been made for the survey of a "ship" canal route from the Illinois River, near Hennepin, to the Mississippi River, at or near Rock Island, Illinois, you are hereby placed in charge of that work.

You will commence the survey on the Illinois River, connecting with the river improvement works now in progress at Henry; ascend the valley of Bureau Creek, and examine thoroughly the water-shed between Bureau Creek and Green River, for a summit level. Connection will thence be made with the nearest available point on Rock River, to supply water to the summit. The explorations for this purpose will be made with a view to construct a navigable feeder. The descent to the Mississippi River will be effected by the valley of Green River. At Rock Island connection will be made with the surveys and levels of the Rock Island Rapids improvement. Careful gauges will be made of Bureau Creek, Green River, and Rock River, to determine the quantities of water available at the lowest stages.

The instrumental survey is to be connected, whenever practicable, with the corners of the general land survey.

Compass-bearings are to be recorded in connection with the angle-readings. The rear chainman will be furnished with a field-book, in which to record all distances, independently of the engineer in charge of the transit.

You will pay particular attention to the geological conformation of the country, and make note of all rock available for building purposes. All information as to depth of wells and character of the soil they are sunk into, will be valuable. Frequent cross-sections will be run across the valleys, sufficient to furnish contour-lines on the maps.

For the convenience of the leveling party, temporary stakes will be set every two hundred feet. Bench-marks will be established at least one in every mile; besides which, the elevations of water-tables, &c., of all permanent buildings along the route, will be entered in the level-books.

If time will allow, at the completion of the survey, you will turn back with the leveling party, and test all benches on the main route. All instruments, when not in use, will be kept boxed up and locked.

You will send to this office full weekly reports of progress, together with your post-office address for the ensuing week.

All calculations and estimates for excavation, locks, &c., are to be based on the dimensions recommended for the enlarged Illinois and Michigan Canal.

You will be careful to limit your expenditures for this survey, and under no circumstances exceed the sum set apart for this purpose.

Very respectfully, your obedient servant,

J. H. WILSON,
Lieutenant Colonel and Brevet Major General, U. S. A.

H. A. ULFFERS,
Civil Engineer Assistant.

Colonel Ulffers and party left this place for Henry, Illinois, on the 5th of September, and immediately proceeded with the survey. During the month of September they were much delayed by the heavy rains; they were, however, enabled to carry the work up the Illinois River, from Henry to Hennepin, and westward from Hennepin twenty-one miles. The field-work will probably be completed by December 1. On September 14, I found it necessary to relieve Colonel Ulffers, and to place Mr. Gorham P. Low in charge of the survey.

I cannot terminate my supervision of the works for the improvement of the rapids of the Mississippi River without again calling attention to the necessity for their completion at the earliest possible day.

There is no physical reason whatever why this should not be done by the end of the working season of 1871, and I do not hesitate to say that considerations of economy and good management, as well as the interests of commerce and navigation, demand that the necessary means should be provided without further delay.

Very respectfully, your obedient servant,

J. H. WILSON,
Lieutenant Colonel and Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Keokuk, October 24, 1870.

GENERAL: In accordance with your orders, I have the honor to make the following report on the improvement of the Des Moines Rapids of the Mississippi River, including the work already done, its present state, and the estimated quantities of work necessary to place it in the hands of the public for use, all being brought to the 30th of September, 1870.

The work, as determined in the fall of 1867, by a board consisting, besides yourself, of Colonel J. N. Macomb, Brevet Major General G. K. Warren, Colonel W. Milnor Roberts, and Captain P. C. Hains, the latter acting as recorder, was as follows:

1st. The excavation of a channel extending from the northern end of the island, at Montrose, to Nashville, a distance of two and a half miles. This excavation not to be continuous, but to be made through the "chains" or patches that might separate the portions of deep water, together with the formation of a bay or entrance harbor, with deep water, at the head of the guard-lock.

2d. A canal from Nashville, at the head of the rapids, to Keokuk, at their foot, with the necessary locks and embankment.

The work necessary for the canal is hence divided into two distinct parts—the canal proper or "section-work," and the three locks necessary for the fall of 19.75 feet from Nashville to Keokuk; and I will consider the matter under the two heads given, leaving out entirely the Montrose Channel, on which no work has yet been done.

On the canal the following is the amount of work done: On earth excavation, 546,596 cubic yards, which leaves to be excavated, according to the original estimate, 119,993 cubic yards; but as there have been 27,421 yards excavated in excess of the original estimate at different points on the line, there really remains 147,414 cubic yards of earth to be excavated.

This large discrepancy arises from orders given during the progress of the work, on account of contingencies that could not be foreseen, and not from any prime errors in the first calculations; the principal cause being an order to carry the excavation of the silt and mud of the river bottom, where it occurred, to the rock bottom—a necessary thing, but not considered in the first estimate.

ON ROCK EXCAVATION.

There have been 248,908 cubic yards excavated, leaving, according to the original estimate, 29,086 yards to complete the work, a quantity which is nearly or quite correct. Hence on excavation of earth we have 77 per cent. done, and of stone, 89 per cent. Although this comprehends the bulk of excavation of the prism of the canal, there yet remains quite an amount of work to be done in clearing up the bottom of the canal and bringing every point down to the accepted grade.

On the embankment, which has necessarily followed the excavation of the prism, the work stands as follows, the materials having been entirely supplied from the excavation:

From the head of the guard-lock, station 32, it stands at grade down to station 84, a distance of 5,200 feet; thence 5,200 feet, to station 136, it is 2 feet below grade; thence 4,200 feet, to station 178, it is 4 feet below grade; thence to station 346, or 16,800 feet, it is up to grade; then for 3,000 feet, to station 376, it is 3 feet below grade; and thence gradually descending through a distance of 3,800 feet to station 414, it runs out to nothing, or 14 feet below grade.

The riprap base-wall, or "toe" of the embankment, is completed from here to the head of the lower lock, at station 424, or 1000 feet, and it is 14 feet below grade.

The embankment slope is to be covered with a wall of dry stone outside, at a slope of 1 on 1½ and of 1 on 1¼ on the inside, while the top is to be covered to a depth of 10 inches with broken stone of the usual size for "macadamizing."

The walls and top-dressing are finished from the head of the guard-lock to station 75, a distance of 4,300 feet; thence the top wall extends in an unfinished condition, from 5 feet to 6 feet below grade, to station 81, and stops.

The inside wall extends in a similar condition to station 79, 400 feet, and then stops.

It then recommences at station 94, runs about 7 feet below grade to station 98, or 400 feet, and then stops.

The next piece of outside wall begins at station 138, and continues 4 feet below grade, to station 157, a distance of 1,900 feet; thence it continues gradually decreasing to nothing at station 162, or 500 feet farther. It begins again at station 180 and continues, entirely finished to grade, to station 236, a distance of 5,600 feet; thence at an average elevation of 7 feet below grade, it extends to station 262, a distance of 2,600 feet, where it stops.

The inside wall is finished up to grade for 400 feet from station 223 to station 227.

Below Price's Creek the outside wall again commences at station 295, and continues at an average of 3 feet below grade to station 345, a distance of 5,000 feet, where it ends, to recommence at station 352, and extends 700 feet to station 359, at an elevation of 6 feet below grade. Here the outside wall finally ends, further work being dependent on the progress and settlement of the embankment.

The inside wall of the embankment begins again at station 314, and runs 2 feet below grade to station 324, a distance of 1,000 feet. Here this wall finally ends. The original estimate of wall, both inside and out, was 75,000 cubic yards; of this 13,915 have been built, leaving to complete the work 61,085 cubic yards.

The original estimate required the changing of the track of the C. B. and Q. R. R. for one and one-half miles, and the raising of the grade at Price's Creek for three-fourths of a mile. This has been done satisfactorily to the railroad company. The last estimate of this work was made and paid in September, 1870.

SECOND LOCK WORK.

In the original plan of the lower lock, it was proposed to make the pier at the lower end 300 feet in length, but on account of its great expense, and the comparatively small benefits to be obtained from this great extension, the length of this pier has been reduced to 150 feet.

No other plans have been materially changed. The lock is thus 350 feet in length and 80 feet wide, filled and emptied by culverts running behind the main walls and connecting with the lock-chamber by small branches.

The work was originally let on August 15, 1868, to Ephraim Owen, to cover the sum of $220,000. He commenced work immediately and has pursued it up to date, except when stopped by high water, with the following results:

1. *Earth excavation completed.*—Amount excavated, 10,414 cubic yards.

2. *Earth embankment.*—The shore embankment is finished up to grade throughout, and is covered with macadam to an average depth of ten inches. The river embankment averages 4 feet 6 inches below grade. Total amount of embankment, 83,447.73 cubic yards.

3. *Rock excavation.*—The rock in the lock-prison has been entirely excavated. Work is still in progress at the lower bay, and will be finished in October. Total amount of rock excavated, 14,310.57 cubic yards.

4. *Concrete masonry.*—The entire foundations for the lock-walls have been made in concrete from 6 inches to 18 inches thick. Great care has been taken in this work, both in the preparation and laying. The proportions used are as follows: 1 part cement, 1½ parts sand, and 3 parts of broken stone. Total amount of concrete laid, 1,051.57 cubic yards.

5. *Lining.*—This designation has been given to the stone laid between the lock-wall and the embankment, and to the covering of the shore embankment. No accurate estimate can be made of what will be required to complete the work. Total amount of lining in work, 1,698 cubic yards.

6. *Puddling.*—Puddling has been used freely whenever the state of the embankment at any point has demanded it. Total amount of puddling, 991.10 cubic yards.

7. *Lead and antimony.*—This item called for in the contract has been furnished to the amount of 410 pounds, used in cementing the iron-work connected with the anchoring and suspension rods.

8. *Wrought iron.*—Four thousand two hundred and thirty-two pounds of wrought iron have been prepared and placed in position as anchoring-rods for the gates. The iron used is Tennessee "AI;" tensile strength, 72,000 pounds; 1¾ inch square, or 2 inches round.

9. *Timber.*—The only timber used has been in the foundation of the river-side vertical wall. Amount, 760 feet, board measure.

10. *Masonry.*—2,433.21 cubic yards constructing cut-stone masonry; 1,381.39 cubic yards constructing cut-stone masonry completing; 3,721.97 cubic yards constructing cut-stone masonry partly done. The latter item is for dressing the stone, for which a relative price of $5 is estimated out of the contract price of $7. The second refers to the setting of the dressed stone.

The following is the state of the masonry: The pier-head is finished to within four courses of the top at the lower end; the portion nearest the wing and the wing itself, on lower left side, is completed, and the coping in position. The main lock-wall is completed, and in condition to receive the coping as far as the upper end of the lower gate recess; from this point up stream, the main lock-wall is raised five courses for a distance of 180 feet, and also the back wall of the supply-culvert to the skew-back.

On the shore side of the lock three courses are laid, from the lower wing-wall to the first culvert in the gate recess. The lower mitre-sill is completed and ready to receive the coping.

11. *Lumber for gates.*—A contract was made in 1869, with James Reardon, to furnish, delivered at the planing-mills in Keokuk, the necessary lumber for the gates of the three locks for $45 per M., board measure, for the best white oak of specific dimensions. After furnishing 42,680 feet, Mr. Reardon declared his inability to fulfil his contract, and a new one was given to Mr. James Carroll for $65 per M.

Mr. Carroll filled the contract in August, 1870, having furnished 125,180 feet, board measure. The quality of this lumber is of the best, and has been furnished of the dimensions given at this office.

12. *Planing.*—The planing was let to Messrs. Copeland, Gray & McClelland at $20 per M., to be delivered on the cars at their mill. On September 30 they had planed 116,644 feet. On these heavy hewn timbers their cutting has been less than half as much more than on thin boards or planks.

13. *Iron.*—The necessary iron for the locks, gates, &c., was let to Morris Sellers, at 5 cents per pound. The cast iron furnished by him has a tensile strength of 21,500 pounds per square inch. He has furnished, up to September 30, 98,496 pounds cast iron in the shape of hollow quoins, wickets, heel-plates, &c.

14. *Cement.*—The cement in use has been furnished by James Clark & Son, of Utica, Illinois. It is a slow-setting, light-colored cement, but for that reason is superior for our purposes to any other that can be obtained here. Their final estimate, dated September 30, was for 3,353 casks, at $2 60 per cask.

It is proposed hereafter to obtain the cement in bags, thereby saving the cost of the barrel, say 25 cents for every 300 pounds.

Very respectfully, your obedient servant,

A. H. BURNHAM,
Captain Engineers and Brevet Major, U. S. A., in local charge.

Brevet Major General J. H. WILSON,
Lieutenant Colonel, U. S. Army, Keokuk, Iowa.

UNITED STATES ENGINEER OFFICE,
Rock Island, Illinois, October 7, 1870.

GENERAL: I have the honor to report the following operations for the improvement of the Rock Island Rapids, for the quarter ending September 30, 1870.

The work on the obstructions has been confined to breaking up detached patches of rock with the chisel, and removing with the dredge the broken rock, together with loose rock left in the channel the year previous, and certain portions of the coffer-dams and cribs protecting them.

The dredge worked upon Campbell's Chain, removing portions of the head and foot of the coffer-dam until the 14th of July, when it was taken up to Sycamore Chain, to remove enough of the lower dam to admit of the passage of steamers through the channel. After it had completed this work it was taken to the head of Sycamore Chain, to remove all the cribs and portions of coffer-dam left in the channel. Meanwhile, the chisel-boat was placed on the ridge of rock covered by the head of the small dam at Sycamore Chain, and the work of breaking up the rock commenced. The dredge, meanwhile, continued clearing up the débris at the head of the chain until the 27th, when the channel was reported clear at this point. The dredge then returned to the foot of the chain, and cleared away more of the coffer-dam from the channel. It was then taken down to the head of Campbell's Chain, to remove broken rock left in the channel the preceding season. It remained here until the 24th of August, when it was shifted, to make room for the steamer and attached sounding-boats.

The dredge dropped down to a position about 1,000 feet below the foot of Campbell's Chain dam, and removed a quantity of broken rock and boulders from the channel. After this, it returned to its former position at the head of the chain, removing all the loose rock that could be found, giving a very good channel through the chain.

The chisel had been at work steadily, breaking up rock at the head of the Little Sycamore dam, until the 7th of September, when it was taken to the foot of the dam to break up a detached piece of rock.

The dredge took its place on the ridge, remaining here until the 14th, when the high stage of the water forced it off. The contractors dropped it down and commenced removing the foot of the coffer-dam, which I stopped, thinking it better to leave it in, for the time, as they had always, before that time, desired the foot to be left in, saying that it aided their work, and I did not see any good reason for taking it up then.

The opportunity was taken of high water to take the chisel-boat to Le Claire and repair the hull. On the 22d the boat was brought down from Le Claire and placed again on the chain. By the close of the month all the broken rock was reported as cleared up, and the foot of the coffer-dam removed. Examination showed that a great deal of very finely pulverized rock had been deposited by the current over the bottom within the small dam. I have no doubt that now that the foot of the dam has been taken out, all this will be swept away; and I purpose to make another examination of this before my connection with the work terminates.

Very high water was experienced during part of September, which, together with rain and wind, interfered greatly with field-work.

During July the line of levels on the Iowa side of the river, taken in 1867, was tested, but the results were not perfectly satisfactory, and I had to leave this question until the completion of the soundings over the different chains, for which I was then preparing. I also ran, myself, over portions of the line on the Illinois side of the river. My desire was to have each side tested by a different person, and to have a third party run the entire circuit—about thirty miles in all—calling each side of the river fifteen miles in length. I will add that a party is now out, October 7th, engaged in leveling the circuit.

The steamer Iowa City was chartered, on the 13th of August, for the purpose of sounding the rapids with attached skiffs or flats. The party was organized in the usual manner, and in charge of Major Hoffman, and worked steadily, excepting when interrupted by rain and wind, until the 6th of September, making and recording the following soundings:

On the Lower Chain	5,000 soundings.
On Duck Creek	19,000 soundings.
On Moline	11,000 soundings.
On Campbell's	21,000 soundings.
On Sycamore	13,000 soundings.
On Smith's	7,400 soundings.
In all	76,400 soundings.

The soundings on the Lower Chain and Smith's Chain were necessary, in order to give more information about the bottom of the river, the soundings taken in 1867 being too meagre. The soundings on the other chains were mainly taken to verify work.

The party returned to the office, and the assistants were set at work to reduce and plot the more important of the soundings for immediate reference. It was found that an important line at the head of Campbell's Chain had been omitted by the pilot.

The work of dredging at the foot of Sycamore Chain was about completed, and being desirous of examining this again, I engaged the steamer Le Claire for two days during the latter part of September, and made some additional soundings.

The party also went up to Smith's Chain, at the head of the rapids, and made some observations upon the directions and velocity of the current at that place.

About 4,000 soundings were taken during this trip.

Very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

General J. H. WILSON,
Keokuk, Iowa.

PEORIA, *Illinois*, *November* 9, 1870.

SIR: In obedience to your instructions, dated October 1, I submit a report of operations for the improvement of the Illinois River during the first quarter of the current fiscal year.

Since the date of my annual report, the operations have been confined to a prosecution of the improvement according to the method set forth in former reports. The press of duty growing directly out of the progress of work under the contract has prevented any attempt at prosecuting investigations into the physical laws of the stream.

The time of the engineer party has been fully occupied in supervising the work under the contract, and in computing the material gathered during the surveys of the summer.

The amount of tedious and monotonous labor has been great, and my attention has been drawn to the desirability of obtaining less laborious methods of preparing the data for estimate of quantities. Progress was made in this direction, but it is yet incomplete; it would be premature to enter into the subject here.

According to your instructions, I prepared a scheme for the expenditure of the $100,000 appropriated for the improvement of the Illinois River at the late session of Congress; before the scheme was submitted, the board of canal commissioners for the State of Illinois suggested essentially the same plan, much to my gratification.

The plan, as adopted, is to expend the means in such way as to afford the greatest possible immediate benefit to navigation, by limiting the work to those points where the greatest obstructions to navigation are found, but making the work at each point according to the ultimate view of securing a continuous depth for navigation of 4 feet at lowest stages, which is the limit of improvement that can be recommended as practicable for an open channel.

The means available were estimated to be sufficient for the removal of seven of the worst bars, whose removal will increase the reliable navigation of the river six inches, or afford a permanent channel of 30 inches in place of 24, as at present. The favorable terms obtained in the contract, awarded since the close of the first quarter, secure the fulfillment of this design.

To complete the work according to the proposed standard of 4 feet draught, as nearly as can now be estimated, will require future appropriations to the amount of $250,000, of which amount $150,000 could be profitably expended during the fiscal year commencing July 1, 1871; a less amount would entail a final increase of the aggregate amount stated above, the completion of the work in two years being an essential part of the estimate.

The progress, during the quarter, in the work of dredging was much retarded by the extremely low stage of water, a condition as properly justifying an extension of the time for the completion of the contract as the opposite extreme would have been. The results of the quarter's work are:

Cubic yards removed at Kickapoo Creek	16,576
Cubic yards removed at Lick Creek	21,272.6
Cubic yards removed at Dutchman's Bar	10,543
Total	48,391.6
Which, at 40 cents per yard, amounted to	$19,356 64
Estimated cost to contractor	11,655 25
Margin for profit	7,701 39

Average cost per yard, $\$0.24\frac{5}{6}$.

The water continued very low throughout the quarter, and for two weeks ranged from one to two-tenths of a foot below the former standard low water.

In the work done the contractor has been compelled to excavate considerably below the depth ordered, in order to obtain space to work his machinery; as a consequence we have an average depth of over 5 feet on shoals, where I was authorized to require no more than 4.3 feet.

I would again mention with commendation the assistant and other employés associated with me, for their diligence and painstaking care in the execution of the duties assigned them.

Very respectfully, your obedient servant,

ROBT. E. McMATH,
Civil Engineer Assistant in Charge.

Lieutenant Colonel J. H. WILSON,
Brevet Major General, U. S. A., Keokuk, Iowa.

H 2.

Report of Captain Edwin Bell, United States inspector of work on Minnesota River.

ST. PAUL, MINNESOTA, *July* 5, 1871.

COLONEL: The work of removing snags from the Minnesota River was resumed on 4th September, 1870, about a mile and a half below Le Sueur, and continued up the stream some ten miles, to the vicinity of Ottawa, over which space the river was entirely cleared of snags.

On the 25th of November, 1870, the working party arrived at Patterson's Rapids, about five miles below the mouth of Yellow Medicine River, and commenced work in the course of a couple of days, taking out boulders from the reefs known as Patterson's Rapids. The boulders were hauled out and placed upon the bank for measurement. The ice-jam drove us away from this part of the river, and we went down to the reef opposite, Ole Johnson's, about two and a half miles below Brown's house, opposite the island, where, as soon as the ice was strong enough to bear a team, we commenced hoisting out the boulders and deposited them entirely out of the way of navigation, and, where it was deemed necessary, formed wing-dams of them, so as to direct the water to one side of the island. We left a number of small boulders both in the straight river and on the reefs; some were frozen down, so that blasting had but little effect on them, and others were covered by ice-jams. There are about 200 yards of boulders remaining in the river, from Yellow Medicine River to where we left off work, a quarter of a mile above Sacred Heart Creek.

I send herewith two tabular statements, in detail, showing the amount of work of each sort done upon the Minnesota River improvement during the year ending 30th June, 1871, by which you will see that there were 743 snags removed and 848 cubic yards of boulders taken out of this stream.

I remain, very respectfully, your obedient servant,

EDWIN BELL,
United States Inspector of Work.

Colonel J. N. MACOMB,
Corps of Engineers, United States Army, General Superintendent United States Improvement Minnesota River, Rock Island, Illinois.

Statement of snag-work on the Minnesota River, to accompany the report of Captain E. Bell, United States inspector.

Date.		Names of localities whence snags were taken.	4 to 6 inches.	6 to 20 inches.	20 to 30 inches.	30 to 36 inches.	36 to 42 inches.	42 inches and over.
1870.								
Sept.	2	First bend below Belle Plaine	1	12	......	......	......	......
	9	Le Sueur Creek	......	26	14	5	1	......
	12	Straight River above Lower Le Sueur	......	10	5	......	......	2
	15	First bend above Lower Le Sueur Ferry	......	38	6	......	1	......
	16	Second bend above Lower Le Sueur Ferry	2	33	7	2	1	......
	21	First bend above Upper Le Sueur Ferry	......	60	18	5	5	2
	27	Hunsucer's Bend	4	54	18	6	2	......
	30	First bend above Hunsucer's	2	53	13	......	1	1
Oct.	7	Straight River above Hunsucer's	......	36	11	1	......	......
	14	Le Sueur's Flats	......	72	16	7	2	......
	19	Wise's Bend	1	41	8	2	......	2
	20	......do	......	18	8	3	2	3
	21	......do	2	30	10	1	......	......
	26	Above Henderson's	......	14	8	......	......	......
	27	High Island Creek	......	8	5	3	4	1
	29	Belle Plaine	......	12	1	1	......	......
		Total	12	517	148	36	19	11

Whole number of snags removed, 743.

Statement of boulder-work on the Minnesota River, to accompany the report of Captain E. Bell, United States inspector.

Date.	Names of localities whence boulders were taken.	Quantity.		
		C. yds.	*C. ft.*	*C. in.*
1870.				
Dec. 7	Reef opposite Brown's stone house	99	5	512
28	Johnson's Reef, about two and a half miles below Brown's, at the island	81	23	1208
28	Reef below camp	12	26	1328
29	Reef opposite Helverson's, one mile below Brown's	18	15	1320
1871.				
Jan. 11	Reef opposite Helverson's, one mile below Brown's	198	24	541
14	......do..................do..................do	15	16	1462
16	Reef opposite Ole Johnson's; worked on reef after ice formed	21	13	1480
19	......do..................do..................do	61	17	1434
21	......do..................do..................do	38	3	756
26	......do..................do..................do	94	5	634
Feb. 1	Working down stream to Old Maid's Island	26	6	31
2	......do..................do	24	....	398
4	......do..................do	11	14	100
6	......do..................do	25	11	360
7	From Old Maid's Island to Boulder Point or Big Island	21	....	1158
9	......do..................do..................do	19	18	766
10	......do..................do..................do	11	19	1246
11	......do..................do..................do	10	....	1416
13	......do..................do..................do	19	9	310
14	Boulder Point to Sacred Heart Creek, 12 miles from Yellow Medicine	11	3	4
15	......do..................do..................do	10	14	1684
17	......do..................do..................do	13	7	1228
	Total	846	16	368

H 3.

UNITED STATES QUARTER BOAT,
Near Beardstown, August 15, 1871.

COLONEL: According to instructions contained in your letter of June 15, I have the honor to submit the following report of operations for the improvement of the Illinois River, during the year ending June 30, 1871:

ORIGINAL PLAN.

At the beginning of the year work was in progress under the contract of F. D. Van Wagenen, with Lieutenant Colonel and Brevet Major General J. H. Wilson, for dredging between the town of Henry and Copperas Creek, under instructions to prepare a bottom for a 7-foot navigation, after a proposed lock and dam at Copperas Creek should be completed.

According to those instructions, the theoretical plane of excavation was parallel to the surface of the supposed pool of the dam, and therefore nearly a horizontal plane; the allowed slope being 0.25 of a foot to the mile.

Referred to the low-water surface of the river, the depth to result from the excavation would vary from 5.2 feet at Crow Creek Bar, to 2.0 feet at Coon Valley Island, where the supposed plane of 7 feet ceased to cut the bottom. According to the plan, the immediate interests of the present navigation were of secondary consideration, and the principal object being connected with a scheme whose execution was a contingent event, did not commend itself to popular favor, and exposed those prosecuting it to adverse criticism, as wasting money at points where no difficulty in navigation ever existed.

MODIFICATION OF PLAN.

The original programme was strictly adhered to until July, 1870, when it was decided to so change the order of execution as first to remove those bars which were giving most trouble to navigation, which being done, criticism was silenced; and the low stage of water compelling the removal of the bars to a greater depth than was designed, the result has been a benefit to navigation, and a reasonable expectation of permanence secured, which would not have followed the carrying out of the original scheme.

Experience quickly justified the opinion that it was impracticable to make a permanent bottom to a grade arbitrarily fixed, in cases where the removal of a few inches only was required.

The material being sand, lies in transverse ridges or reefs; consequently a cut of less than half a foot would do no more than level off the crests of the ridges, which, in running water, would very quickly be replaced; for this reason it was deemed best to confine the dredging to the bars, from which a sufficient quantity was to be taken to afford material to effect changes in the area of flow, to confine the water to the channel, and to lower the grade below the prescribed plane, so that the crests of the inevitable reefs should be below that plane.

In consequence of these necessary modifications, no dredging was done below Kingston, and the grade was lowered at Lick Creek, Tamarsh Island, and Dutchman's Bars; the last two localities have been designated in former reports as one bar—"Kingston Flats."

The above-described modifications being made, the work was carried out without sacrificing any important part of the original intention, while affording a decidedly better channel for present use, which promises to be permanent.

PROGRESS DURING FISCAL YEAR.

The progress of the work up to the date of the last report had been slow, but by additions to the working equipage, and other expedients, the rate was increased, and good progress made during this latter half of 1870. In the spring of 1871 work was continued under this contract until June 16, when it was suspended on account of supposed exhaustion of the appropriation. A later examination discovered an available balance, and work is now in progress upon the points left incomplete at that date.

The result of the work under this appropriation has been to afford a channel of 5 feet from Henry to Peoria, thirty-seven miles, and a further extension of fifteen miles, with a depth of 4 feet, and a bottom for a 7-foot navigation is now prepared, reaching to Copperas Creek, if the dam be raised six inches higher than first proposed. But as the construction of that dam at an early date is very improbable, and as several bars are left, which will now be considered serious obstacles, they will be included in the estimate of further work required.

PROVISIONS FOR FUTURE PROGRESS.

In August last I was directed to submit a scheme for the expenditure of $100,000, appropriated by Congress at the session of 1869–'70.

ENGINEERING.

Failing to be convinced of the necessity of so costly an improvement as that by locks and dams, and in view of the fact that in any case the execution of that plan was uncertain, I favored a project in which the present benefit was the leading object.

Previous to submitting the project, the commissioners for the State of Illinois proposed essentially the same, which, being adopted, renders the work of the United States and that of the State distinct, but not conflicting.

The project contemplates the prosecution of the work on the part of the United States, with a view to make an open channel navigation, with a minimum depth of 4 feet, by dredging and constructing dams to control the water, which, if means are promptly provided, can be done in two years.

The limit just mentioned, of 4 feet, we know can be secured at moderate cost, and maintained at about the same expense as for maintenance and attendance of the five locks and dams proposed; and this depth will amply satisfy any possible demand upon the river until the enlarged canal, talked of but not in progress, is ready for use.

In carrying out the scheme, it was decided not to let the work in sections, to be entirely completed up to the proposed standard, but to classify the bars according to their character as obstructions, and to remove them in the order of classification.

For the removal of the first class, including all having less than 2.5 feet at lowest stage, proposals were invited by advertisement, dated September 6, 1870.

Profiting by experience, it was also decided to protect the work from deteriorations by making the excavation 6 inches below the line of 4 feet draught, limiting the excavation to those portions of the shoal where the original depth was less than 4 feet.

In making location of the lines of proposed channels, the natural channel is taken as a guide, unless both economy and convenience in use suggest a change.

In all cases, the lines are either tangent or very flat curves. As it was important to have the curves conform to the shape of the natural banks, a laborious investigation was made to determine the curve that would satisfy the condition, resulting in a formula which closely follows the banks, and is also very convenient in use. The formula is for a polar curve, in which the radius vector $=a+\left(\frac{n^2+n}{2}\right)c$, in which a is assumed as a round number greater than the width of the river, and c determined by equations of condition that the curve is to pass through three selected points, as deposit of excavated material is intended to aid in confining the current to the channel at all stages below a mean. The limits of deposit-ground are also defined by curves of the same species. As the method has been tested by a year's experience, during which the river has passed its ordinary variations of stage without, in any case, developing any tendency to fill up the excavated channels, it is hoped that the labor spent in elaborating the method was not in vain.

Under the first contract dredging alone could be done; therefore I was unable to fully carry out what I thought desirable in the way of protecting the works. The latter contract provides for some cases, and I am satisfied, from the success so far attending them, that it would be well to increase the item of protection still further.

PROGRESS DURING THE YEAR.

Up to the close of the year the work done by F. D. Van Wagenen was located at the following places:

Localities.	Cubic yards of material.	Price per yard.	Amount.
Foot of Henry lock	4,932.6	$0 40	$1,973 04
Spring Branch	3,249.7	40	1,299 88
Crow Creek	5,314.0	40	2,125 60
Senachwine Creek	5,575.7	40	2,230 28
Peoria Bridge	4,346.0	40	1,738 40
Peoria Flats	54,797.5	40	27,919 00
Kickapoo Creek	16,576.0	40	6,630 40
Lick Creek	31,295.8	40	12,518 32
Tamarah Island	22,916.0	40	9,166 40
Dutchman's Bar	28,775.0	40	11,510 00
Total dredging	177,778.3	40	71,111 32
Removing wreck			306 00
Removing snags			90 00
Total of work to June 30, 1871			71,507 32
Engineering expenses			9,336 27
Total			80,843 59

Which represents the total cost of improving fifty-two miles of river, which is now complete.

The work mentioned above as done at Henry lock was planned and directed by the engineer of the lock, Mr. D. C. Jenne.

FUTURE PROGRESS PROVIDED FOR—WORK.

For the expenditure of the appropriation made in 1870, a contract was made October 18, 1870, with James T. Hayden, who, after the delay necessary to build the required boats, reported ready for work January 2, 1871, since which date work has progressed, except when suspended for repairs and other frequent mishaps.

The contractor being notified to increase his force, has made arrangements to do so, but the additional machinery has not yet arrived upon the work. With the expected increase, the completion of his contract within the next fiscal year is assured. Under this contract, the following work has been done:

Localities.	Cubic yards of material.	Price per yard.	Amount.
Devil's Elbow Bar	42,298.5	$0 24¾	$10,468 88
Toll Gate Bar	14,351.0	24¾	3,551 87
Dam No. 2, at Beardstown Bar	242.8	2 00	485 60
Total to July 1, 1871			14,506 35

The last two items were incomplete at the close of the year.

The existing contract covers the following bars, for which the means now available will be ample, in addition to the above:

1. Moore's Island.
2. Naples Flats.
3. Big Blue River.
4. Little Blue River.

SURVEYS AND RESURVEYS.

During the past year no extended surveys have been made. A change in the method of conducting them puts it in the power of the regular engineer party employed to lay out and direct the work, to make very elaborate surveys, which heretofore required a large party; and now the soundings are taken immediately in advance of the dredging, therefore the only surveys have been of the bars worked on.

A large amount of material on hand at the beginning of the year has been worked up and plotted on the several scales required for working and record sheets.

In working up the results of the surveys of June, 1870, my attention was drawn to the numerous errors made in reading and recording depths measured by hand, and the failure to develop the shape of the bottom by detached surroundings; also, it was found a very laborious matter to test the excavated channel for lumps and ridges.

These considerations led me to study the problem of mechanical sounding under the conditions noted; the result was a machine working on the principle of the pantagraph, recording a continuous profile of the ground passed over, which, being applied to the system of pontons already in use, gave satisfactory results, and after being fully tested, the machine was purchased for the Government on your recommendation.

The machine not only gives better results than hand labor, but greatly reduces the expense for field and office work. Tested both by crossings, duplications, and by comparison with rod soundings, the results are always correct.

WORK REQUIRED TO COMPLETE THE IMPROVEMENT.

Whatever may be said in favor of a slack-water improvement, in connection with the enlargement of the Illinois and Michigan Canal, considered as a military or naval measure, or in view of a possible development of commerce over the line, there can be no dispute that, until the canal is complete, an open channel of 4 feet depth is ample to satisfy the trade, and, as a canal project would be the work of many years, it is my opinion that to foster the trade by opening and maintaining a good channel equal to the present canal is all that can now reasonably be asked of the General Government.

Former reports, recommending a much more costly improvement, contain arguments which may safely be referred to, to justify a less expensive one, such as is now in progress, and which can be completed according to the following estimate, covering the entire river now unimproved:

ESTIMATE.

The estimate is made for a channel 150 feet wide and 4½ feet deep in excavation, with dams to confine the water when required.

Localities.	Style of work.	Cubic yards in dam.	Cubic yards in excavation.
Lancaster Flats	Dredging		37,600
Coon Valley Island	do		23,593
Do	Dam	580	
Canton Landing	Dredging		35,900
Copperas Creek	do		19,623
Spoon River	do		10,990
Devil's Elbow	do		*42,298
Grand Island	do		128,772
Do	Dam	1,139	

Localities.	Style of work.	Cubic yards in dam.	Cubic yards in excavation.
Sangamon River	Dredging		7, 344
Dutchman's Creek	do		4, 778
Sugar Creek Island	do		9, 630
Do	Dam	1, 271	
Sugar Creek Bar	Dredging		60, 936
Toll Gate Bar	do		*28, 065
Bar at Beardstown	do		14, 200
Beardstown Bar	do		*56, 516
Do	Dams Nos. 1 and 2.	*1, 682	
Beaver Dam Bar	Dredging		10, 718
Indian Creek	do		48, 112
Moore's Island	do		*36, 724
Do	Dam	*1, 157	
Eagle Island	Dredging		18, 574
Wilson's Island	do		21, 057
Meredosia Bar	do		20, 801
Meredosia Island	do		17, 289
McKee's Creek	do		33, 987
Do	Dam	810	
Naples Bar, (upper)	Dredging		10, 067
Naples Bar, (lower)	do		14, 043
Gar Island	do		89, 054
Do	Dam	1, 470	
Blue River	Dredging		*50, 419
Do	Dam	*1, 230	
Bevington Bar	Dredging		18, 296
Florence Bar	do		3, 442
Little Blue River	do		15, 710
Do	Dam	343	
Slim Island	Dredging		27, 416
Pilot Peak	do		19, 203
Buckhorn Island	do		22, 993
Do	Dam	1, 390	
Grand Pass	Dredging		141, 538
Do	Dam	1, 620	
Otwell's Bar	Dredging		37, 333
Do	Dam	930	
School House	Dredging		21, 445
Apple Creek	do		13, 037
Columbiana	do		31, 592
Hurricane Island	do		7, 556
French Bar	do		28, 889
Do	Dam	1, 390	
Bloom's Landing	Dredging		30, 000
Six-mile Island	do		37, 500
Totals		15, 012	1, 305, 040

* Provided for by means now available.

COST.

1,305,040 cubic yards dredging, at 25 cents per yard	$326, 260 00
15,012 cubic yards dams, at $2 per yard	30, 024 00
Engineering and contingencies	35, 628 40
Total estimated cost	391, 912 40
Deduct present appropriation	100, 000 00
Balance to be appropriated	291, 912 40

of which $150,000 could be profitably expended during the coming fiscal year.

The foregoing estimate is made for the improvement of West Point chute at Grand Island; and as to make the improvement permanent it would be necessary to close the Bath chute, which, as the traffic at Bath is inconsiderable, might properly be done, locating the dam near the lower end of the island would give a good slack-water navigation from the head of the island to all the points needing any accommodation, and relieve the general trade from the disadvantage of navigating a very narrow and crooked channel, and the Government of the additional expense of over $30,000, which would be required to make 4 feet depth in the Bath chute.

As there would doubtless be local opposition to the proposed plan, it would be desirable for the formal authority of Congress to be given in the appropriation bill.

As (if the plan is to be carried out by classification) Grand Island would come into the class next to be put under contract, the attention of the Department is respectfully invited to secure the authority the coming session.

WHAT IT WILL ACCOMPLISH.

The amount asked for next year will be sufficient to make a 3-foot navigation throughout the river by the removal of the following bars:

1. Lancaster Flats.
2. Canton Landing.
3. Grand Island.
4. Sugar Creek.
5. Indian Creek.
6. Gar Island.
7. Bevington.
8. Buckhorn.
9. Grand Pass.
10. Otwell's.
11. School-House.
12. Apple Creek.
13. French.
14. Bloom's Landing.
15. Six-mile Island.

PUBLIC UTILITY.

The public utility of the improvement is by no means to be measured by the amount of trade actually passing over the river, which, of itself, is sufficient to justify all that is now asked, but there is an indirect influence which cannot be expressed in figures, exerted in moderating transportation charges over competing railroads. In the direct and indirect influences of the improvement, the whole of the region reached by the Mississippi and its branches is more or less interested, according to the extent of the commerce with the North and Northeast.

MAINTENANCE AFTER COMPLETION.

The most economical mode of maintenance would be for the Government to do the necessary work without contracts, to do which would require a first outlay of $20,000 for machinery and boats, and an annual appropriation of $8,000 for working expenses. To do the same by contract would require $12,000 annually.

The river lies in several collection districts, (internal revenue,) whose designation and amount of collections are unknown at this office.

The nearest port of entry is St. Louis, but the amount of revenue collected during the year is not known.

Very respectfully, your obedient servant,

ROBERT E. MCMATH,
Civil Engineer Assistant.

Colonel J. N. MACOMB, *Rock Island, Ill.*

Abstract of proposals received at the United States engineer office, Peoria, Illinois, October 6, 1870, *for furnishing materials and doing all the work for the improvement of the Illinois River, according to advertisement dated September* 3, 1870.

No. of proposal.	Name and residence of bidder.	Name and residence of guarantors.	Certified to by—	Dredging 200,000 cubic yards.		Riprap dams 1,114.5 cub. y'ds.		Brush and gravel dams 2,057 cubic yards.		Aggregate for all work.	Remarks.
				Rate per yard.	Amount.	Rate per yard.	Amount.	Rate per yard.	Amount.	Amount.	
1	James T. Hayden, Chicago, Illinois.	John C. Clifford, S. H. Kneeland, New York city.	J. M. Van Buren, U. S. pension agent, N. Y. city.	$0 24¾	$49,500 00	$4 00	$4,458 00	$4 00	$8,228 00	$62,186 00	
2	L. W. Wilson, Canajoharie, Schoharie County, N. Y.	J. C. Van Horn, J. C. Newkirk, Canajoharie, Schoharie County, N. Y.	W. C. Stripe, assistant assessor first district Iowa.	31	62,000 00	4 00	4,458 00	2 75	5,656 75	72,114 75	
3	F. D. Van Wagenen, Keokuk, Lee County, Iowa.	George Williams, Ephraim Owen, Keokuk, Lee County, Iowa.	W. C. Stripe, assistant assessor first district Iowa.	33	66,000 00	4 00	4,458 00	2 25	4,628 25	75,086 25	
4	H. M. Hempstead, Saginaw, Saginaw County, Michigan.	Frank McAllister, E. D. Wright, Saginaw, Saginaw County, Michigan.	W. C. Stripe, assistant assessor first district Iowa.	29	58,000 00	3 85	4,290 83	2 50	5,142 50	67,433 33	
5	John McElroy, Buffalo, Erie County, New York.	James Hyland, Joel T. Comstock, Buffalo, Erie Co., N. Y. New York.	Colonel J. G. Stiker	25	50,000 00	Unintelligible.		Unintelligible.		....	Informal in two respects: 1st. Certifying party unknown to this office, and does not purport to be a United States official. 2d. Indefiniteness of the proposal.
6	Andrew Watkins, Albany, Albany County, New York.	George Taylor, James Lamb, Albany, Albany County, N. Y.	John F. Smythe, postmaster.	30	8,711 10	......	....	......	....	....	Devil's Elbow Bar, 29,037 cubic yards; Toll Gate Bar, 21,826 cubic yards; Beardstown Bar, 40,718 cubic yards; Morris Island Bar, 32,200 cubic yards; Naples Flats, 23,007 cubic yards; Big Blue River, 38,637 cubic yards; Beardstown No. 1, 857 cubic yards; Beardstown No. 2, 343 cubic yards; Moore's Island, 857 cubic yards; Sugar Creek, 343 cubic yards; Big Blue River, 482.5 cubic yards; Little Blue River, 343 cubic yards.
				30	6,547 80						
				30	12,215 40						
				30	9,660 00			0 75	642 75		
				30	6,902 10			0 75	257 25		
				75	28,977 75			0 75	642 75		
					73,014 15	*3 00	90,274 50		1,542 75	164,831 40	
7	Norris G. Dodge, Rensselaer R. Dodge, Cleveland, Ohio.	Charles Pardee, Lucian Moses, Skaneateles, Onondaga County, N. Y.	John H. Smith, assistant assessor twenty-third district N. Y.	28¾	57,500 00	†5 00	5,572 50	4 00	8,228 00	71,300 50	

* Rate per cubic foot. † Per cubic yard.

J. N. MACOMB,
Colonel Engineers, U. S. A., General Superintendent United States Improvement Illinois River.

Abstract of contracts entered into during the fiscal year ending June 30, 1871, for the improvement of the Illinois River.

Date.	Name and residence of contractor.	Name and residence of bondsmen.	Subject of contract.	Amount.	Remarks.
1870	James T. Hayden, Chicago, Ill.	Adrian R. Root and John W. Embler.	Dredging and constructing riprap and other dams, between Copperas Creek and the mouth of the Illinois River.	$100,000	After deducting the necessary expenses for contingencies and engineering.

J. N. MACOMB,
Colonel Engineers, U. S. A., General Superintendent U. S. Improvements on Illinois River.

H 4.

UNITED STATES ENGINEER OFFICE,
Keokuk, Iowa, August 1, 1871.

COLONEL: I have the honor to submit to you the following report of the operations performed on improvements of the Des Moines Rapids for the fiscal year ending June 30, 1871.

SECTION WORK.

From an application made on May 23, 1870, permission was granted to extend the contract of Messrs. Dull & Williams to take effect July 12, covering the sum of $250,000. The contractors pushed forward the work immediately, and performed the following amount of labor up to November 9, the date of closing the contract: One and a half miles bailing and draining; 124,685.70 cubic yards excavation of earth; 80,792.90 cubic yards excavation of rock; 4,155.00 cubic yards embankment grading railroad track; 156.00 cubic yards labor of puddling; 12,813.60 cubic yards face stone in riprap walls. These quantities have been distributed along the line of the canal wherever it has seemed necessary and proper in the eyes of myself, under the direction of General J. H. Wilson, until September 30, 1870, and since that time of yourself.

In July, 1870, 3,152 cubic yards of embankment were made on the Chicago, Burlington and Quincy Railroad, completing this portion of the work, rendered necessary by the location of the middle lock, and the raising of the high water in the canal above the old grade of the track, &c.

In September much delay was experienced on account of the sudden rise in the river; however, no damage was done to the work further than the delay occasioned, which, by comparison of the estimates for this month and the preceding, was about 25 per cent.

On November 1 I directed the contractors to discontinue the excavation of the rock and put the entire force into earth, so as to close, as far as the funds available would permit, the gap existing in the embankment above the lower lock. This was accomplished, and no trouble was experienced during the winter and spring, as we were fortunate enough to have a comparatively low stage of water until the work recommenced in February, under the special appropriation of $341,000, made January 18, 1871. Approximate estimates were made daily, in order to keep the work within the limits of the funds available, and yet obtain as much work as possible. By this rate I stopped all work on November 9, and found that I had really allowed the contractors to work too long, as they had a balance due them, after expending the contract money of $9,500; but there being other money available, permission was obtained by you to settle this account.

In this connection, I would call your attention to the utter impossibility of keeping accurate knowledge of each day's work on a work of this kind and magnitude, and this was the cause of the overrunning of the appropriation.

On January 18, 1871, a bill was signed by the President, giving "for the completion of the section-work of the Des Moines Rapids improvement," $341,000. I immediately started to Rock Island to consult with you, and orders were received soon after from the Chief of Engineers to offer the former contractors, Messrs. Dull & Williams, a new contract at their former rates. This offer was accepted by them, and on January 30 they commenced clearing their track, &c., for commencing work. This was very tedious on account of the large amount of snow and ice. But by hard work the first train of earth-cars was run down on the 15th of February, and of stone on the 22d. The new contracts were signed and forwarded on the 17th of February.

From the commencement of the work under the contract, the following amount of work was performed to the end of the fiscal year:

Grubbing and clearing three-fifths of the whole work; five and a half miles bailing and draining; 88,100 cubic yards excavation of earth; 64,728 cubic yards excavation of rock; 26,746 cubic yards face-stone in riprap walls.

In order to save dissensions and to guard against any future claims that might be made against the Government, I inserted, by your permission, a clause into the contract, that any stone or earth taken from the prism of the canal, although beyond the limits of the theoretical prism, either in breadth or depth, should be considered and paid for as excavation, although in reality "borrowed." By this means a considerable amount was saved to the Government, besides endless trouble and annoyances to the engineer in charge.

In April I was compelled to use the above article of the contract in order to obtain good building-rock, and ordered a stratum, or "ledge," below the theoretical bottom, to be opened, and material obtained for the riprap.

During the month of April much trouble was experienced from the height of water in the river, causing leaks from the "head of water" given by the pumping out of the pits. These leaks are invariably through the rock, or rather between two strata, the "seam" or plane of stratification being opened by the blasting necessary for the rock excavation. These leaks cause no damage to the work, with the exception of the delay caused by them. The cost falls wholly upon the contractors, falling in the item of "bailing and draining," and is consequently one of the uncertain parts to be considered by them in taking the work.

On the 18th of May the river reached its maximum stage, and commenced receding on that date. During this high stage several of the leaks above mentioned occurred in one pit, "Stott's Mill," and compelled the closing of the same for 3,650 feet. No delay to the work was occasioned, as the entire available force was immediately transferred to another position.

During the season of 1871 I have endeavored to push, with all the speed compatible with good work, the riprap wall of the embankment, in order that it (the embankment) may be protected from the effects of the ice in the coming winter. In this I have succeeded, and have raised (or shall have done so by August 1, when the funds will be exhausted) the embankment so as to have it safe from an overflow from anything but unusually high water. I have also completed the riprap wall on all portions of the line where the embankment was old and well settled.

My assistant on section-work has been Mr. E. Hudson Worrall, civil engineer, who has been connected with the work since December, 1867. He is a most competent and efficient engineer, and I am greatly indebted to him for his indefatigability in the pursuit of his duties. With him I associated this spring Mr. A. H. Blaisdell, civil engineer, a young but highly efficient engineer.

LOCK-WORK.

The contract for this work was let in 1868 to Mr. E. Owen, covering the sum of $220,000, and the balance of this sum which remained on hand July 1, 1870, was expended on the 20th of October. In addition to this, he performed additional labor covering the sum of $16,361 23. Available funds being on hand, permission was asked and obtained to pay this amount. In the mean time, Mr. Owen refused to prosecute the work further on his old contract, and consequently I determined to employ a small force and push, by days' labor, (using Mr. Owen's tools,) the work necessary to place the lock in a condition to stand the winter. This was done by bringing the masonry of the lock-wall to a level course, laying the roussoins of the filling-culvert on the river side, and, this being completed, covering the green masonry exposed with manure and clay, to protect it from the frost. I also repaired the coffer-dams and embankments about the lock, protecting the portions exposed to the action of the ice, which often gorges at this point, by a riprap of refuse stone; by this means I was able to save the lower corner of the main coffer-dam, which would inevitably have been carried away but for these timely precautions.

During the winter many trifling difficulties were met and overcome; the major part of these are not worth mentioning, as they are continually arising in the progress of the work.

On March 3, 1871, the President approved the general appropriation bill, in which was the sum of $250,000 for this work. I immediately forwarded to you projects of operations, with the necessary copies of proposed advertisements, &c., which, meeting with your approval, you sent to Washington, and received back on the 29th.

In the mean time I took active steps to reorganize my force for the resumption of the work. The advertisement called for bids on both middle and lower locks, and for cement at both places.

I opened the bids in your absence. The following are abstracts showing an aggregate of all the bids received for the lower and middle locks. That for cement will be found under that head:

Lower lock.

No.	Name of bidder.	Residence.	Amount.
1..	F. D. Van Wagenen	Fulton, New York	$121,785 00
2..	John L. Zwart	Keokuk, Iowa	103,215 00
3..	*Ephraim Owen	Albany, New York	113,535 00
4..	Richard Lloyd	Rock Island, Illinois	120,390 00
5..	James M. Rice & Co	Keokuk, Iowa	119,225 00
6..	Dull & Williams	do	127,810 00
7..	James Gowan	Chicago, Illinois	132,500 00
8..	Willard Johnson	Fulton, New York	120,200 00
9..	W. S. Nelson	do	142,050 00
10..	Thomas Holland	Chicago, Illinois	94,615 00

* Lowest responsible bidder.

Middle lock.

No.	Name of bidder.	Residence.	Amount.
1..	F. D. Van Wagenen	Fulton, New York	$113,939 50
2..	W. F. Bushnell	Mendota, Illinois	320,000 00
3..	Quinn & Burke	Keokuk, Iowa	118,695 98
4..	John McCune	do	135,347 00
5..	Steele & Fletcher	do	133,261 50
6..	Owen & Wells	do	141,885 00
7..	Charles Fitzsimons	Chicago, Illinois	143,333 50
8..	Brownell & Tobie	Keokuk, Iowa	151,810 40
9..	Richard Lloyd	Rock Island, Illinois	129,688 00
10..	James M. Rice & Co	Keokuk, Iowa	131,814 00
11..	Dull & Williams	do	160,120 00
12..	*Willard Johnson	Fulton, New York	110,403 30
13..	W. S. Nelson	do	196,213 00

* Lowest responsible bidder.

In the pursuance of my duty I found it necessary to reject the lowest bidder for the lower lock, he not being considered responsible, and recommended that the contract be awarded to Mr. E. Owen, the original contractor, as the "lowest responsible bidder."

The lowest bidder for the middle lock was Mr. Willard Johnson, of Fulton, New York, and the contract was awarded to him.

As soon as the approval of these recommendations was received, I gave notice to the parties to commence immediately; this date was May 23, the contracts being executed on the 31st of the same month.

Both contractors went immediately to work. I give below the amount of work performed by each, making no further remarks than that the work to June 30 progressed in a very satisfactory manner.

Amount of work done by Mr. Owen under his contract dated August 15, 1868, during fiscal year ending June 30, 1871, as follows:

Rock excavations	7,510,262	cubic yards.
Embankment	2,219,000	cubic yards.
Surplus stone placed in base of riprap-wall above lock-section	2,883,300	cubic yards.
Cut-stone masonry in lock-walls, (partly done,)	1,309,150	cubic yards.
Constructing cut-stone masonry in lock-walls, (completing)	1,959,880	cubic yards.
Constructing cut-stone masonry in lock-walls	2,349,055	cubic yards.
Concrete masonry	1,217,320	cubic yards.
Pounds, handling and putting into work wrought iron	5,857	pounds.
Labor of puddling	891,100	cubic yards.
Lining	1102.3	cubic yards.
Pounds lead and antimony	410	pounds.

Amount of overwork done by Mr. Owen during fiscal year ending June 30, 1871, as follows:

Constructing cut-stone masonry	1,000,105	cubic yards.
Embankment	17,019.08	cubic yards.

Amount of work done by Mr. Owen under his contract dated May 31, 1871, during fiscal year ending June 30, 1871, as follows:

Bailing and draining three-fifths of the whole amount.

Earth excavation	6.765.34	cubic yards.
Earth embankment	6.707.517	cubic yards.
Rock excavation	340	cubic yards.
Loose stone	374.25	cubic yards.
Lining	53.33	cubic yards.

Constructing masonry,	2. 093. 373 cubic yards.
Constructing masonry, (partly done,) (stone dressing)	599. 76 cubic yards.
Constructing masonry, (completing)	270. 60 cubic yards.

Amount of work done by Mr. Johnson under his contract dated May 31, 1871, during fiscal year ending June 30, 1871, as follows:

Bailing and draining one-half of the whole amount.	
Earth excavations	1, 304 cubic yards.
Rock excavations	2, 410 cubic yards.
Earth embankment	1, 328 cubic yards.
Puddling	833 ½ cubic yards.
Constructing masonry for lock-walls, (partly done,) (stone, dressing)	139. 25 cubic yards.

STONE.

The contract for stone was awarded to Charles G. Case & Co. on the 10th June, 1869, and under this was delivered the following amount of stone during the fiscal year:

Face-stone	3, 475. 99 cubic yards.
Backing-stone	2, 878. 02 cubic yards.

This contract expired on the 26th of August, 1870, and as more stone was immediately required, General Wilson ordered a canvass of the open market, with the following result:

	Face-stone.	Backing-stone.	Rubble-stone.
R. U. McClonchy, per cubic yard	$16 50.	$9 50.	$9 00
Charles G. Case & Co., per cubic yard.	13 50.	8 00.	3 00

Consequently $60,000 was allotted by General Wilson for the purchase of stone from Charles G. Case & Co., subject to the same rules, &c., as were contained in their first contract.

Under this agreement was delivered the following amount:

Face-stone	2, 125. 86 cubic yards.
Backing-stone	2, 292. 14 cubic yards.

I ordered them to stop the delivery of stone on the 8th of November, 1870, and the order was carried into effect the same day.

No further use for stone was had until the lock-work commenced, and in order to prepare for that, having been directed to advertise, and not to purchase in "open market," I hauled from the middle lock all that was sufficient for the immediate prosecution of the lower lock. Advertisements were made for stone on May 15, and opened by me in your absence on June 15, 1871, with the following result:

Stone for lower lock.

No.	Name of bidder.	Residence.	Amount.
1	F. D. Van Wagenen	Fulton, N. Y.	$74, 450 00
2	Dull & Williams	Keokuk, Iowa	73, 850 00
3	*Wells, Timberman & Co	do	71, 400 00
4	*William Brownell	do	51, 700 00

* Lowest responsible bidders.

In the mean time Messrs. Wells, Timberman & Co. handed me a written offer to furnish stone up to the time of the letting, at the same rates as might be granted to the successful contractor.

This I forwarded to you with a favorable indorsement, and having been approved by the Secretary of War, they delivered, up to the 15th of June, the following amounts:

Face-stone	81.60 cubic yards.
Backing-stone	161.19 cubic yards
Rubble-stone for slope-wall	939.15 cubic yards.

All the quarries, from the owners of which bids were received, were inspected by me and Mr. J. E. Griffith, (late lieutenant United States Engineers,) one of the best judges of magnesian limestone in this country, so that the quality of stone to be furnished could be known.

On the opening of the bids it was found that the lowest bidder, William Brownell, had presented a very informal bid, with only one responsible guarantor, and, as his quarry would furnish stone that was dangerous to use for our purposes, being full of "dregs" and "sand-holes," I made the recommendation that the contract be awarded to the next lowest bidders, Wells, Timberman & Co. This was approved by you, and afterward by the Secretary of War. (The contract was signed on the first day of July, 1871.)

The stone is of the best quality of magnesian limestone in the western country, and is entirely satisfactory, as a building-stone, for our purposes.

CEMENT.

The contractor for this article was James Clark, of Utica, Illinois. The cement furnished was slow in setting, but only enough so to allow work in laying stone to progress without delay. This contract ran out on the 30th day of September, 1870, the following being a showing of the amount of cement delivered by him during the fiscal year: 2,223 casks, 300 pounds each. After the expiration of this contract, I made arrangements, with your consent, to buy the small amount necessary for the further pursuance of the work till frost set in, in "open market." Mr. Clark offered to furnish at the following rates: 300 pounds in barrels, at $2 40; 300 pounds in sacks, at $2 15. His offer was accepted, and we purchased of him, up to November 2, 1870, 64 barrels in sacks and 79 barrels in casks.

On the recommencement of work on the locks it became necessary to again purchase cement, and the following is the abstract of bids opened on the 29th April, 1871:

Cement for lower and middle lock.

No.	Name of bidder.	Residence.	Amount.
1	Andrew Sabine	Louisville, Ky	$92 16
2	*James Clark	Utica, Ill	85 92

* Lowest responsible bidder.

Mr. James Clark, being the lowest bidder, was awarded the contract, and to June 30, 1871, has furnished the following amount of cement, equal in all respects to the quality used in 1870: 685 casks, 300 pounds each; 113 casks in sacks, 300 pounds each.

CASTINGS.

During the year the contractor, Morris Sellers, has furnished the entire amount of castings, completing his contract on the 19th day of May, 1871.

The iron is of the finest quality, one specimen (the first) bearing a tensile strain of 21,500 pounds, while the second specimen required 29,000 pounds to the square inch to break it.

Some few items have been obtained in open market during the year, but not of sufficient account to mention in this report.

PLANING.

The contractors, Messrs. Copeland, Gray & McClelland, have finished their contract during the past year, having performed the following amount of work, with entire satisfaction to myself, up to the 17th day of November, 1870, when they completed their contract: 113,390.66 feet, board measure.

TIMBER.

The contract for timber for the lock-gates was given, on the 10th day of March, 1870, to James Carroll. On August 16th he completed his contract, having furnished of the finest quality of white oak timber the following amount: 125,179.7 feet, board measure.

For the completion of the improvements at this place I estimate that $1,000,000 will be necessary, all of which could be employed during the year ending June 30, 1873. In fact, it would be of great monetary advantage to the Government if the necessary funds for completing the work could be furnished immediately, instead of by small annual installments. So much has been already said on this subject and on the absolute necessity of completing the work immediately, that I will not enlarge upon them in this report.

In closing I must express my thanks to all my civil assistants, especially Mr. E. H. Worrell and Mr. J. E. Griffith, for their cordial co-operations in my endeavors to forward the progress of the work.

The following is an abstract of contracts made during the fiscal year:

No.	Name and residence.	Date of contract.	Designation.	Amount.
1	Ephraim Owen, Albany, N. Y	May 31	Lower lock	$113, 535 00
2	Willard Johnson, Fulton, N. Y	May 31	Middle lock	110, 403 30
3	James Clark, Utica, Ill	May 31	Cement	8, 592 00

Statement of cash received, expended, and remaining on hand during the fiscal year ending June 30, 1871.

Amount received	$494, 979 70
Amount expended for lock-work	189, 988 03
Amount expended for section-work	405, 635 13
Amount expended for land damages,	10, 300 60
Whole amount expended	605, 923 76
Amount due from the United States	110, 944 06

All of which is respectfully submitted by your most obedient servant,

A. H. BURNHAM,
Captain, Corps of Engineers, Brevet Major, U. S. A.

Colonel J. N. MACOMB,
Corps of Engineers, U. S. A., Rock Island, Illinois.

H 5.

UNITED STATES ENGINEER OFFICE,
Rock Island, Illinois, September 1, 1871.

COLONEL: I have the honor to submit the following report of the operations for the year ending June 30, 1871, pertaining to the improvement of the Rock Island Rapids of the Mississippi River.

Brevet Major Charles J. Allen, captain Corps of Engineers, was in local charge at these rapids, under the superintendence of Brevet Major General J. H. Wilson, United States Army, and under him the work was progressing as follows:

OF THE COFFER-DAM AT CAMPBELL'S CHAIN.

The excavation at this chain was finished during the year ending June 30, 1870. Very little had been carried off by the ice and high water, and it was, therefore, necessary in order to give to navigation a clear channel of at least 200 feet in width and 4 feet in depth below low water of 1864, to remove all obstructions. In July, chisel and dredge were set to work at this chain, and at the head and foot of the dam. All cribs, portions of dam, piles of loose stones, and patches of rock upon which the dam had been resting, were removed, and thereby the proper width and depth of the channel obtained. That side of the dam running parallel with the stream from head to foot of dam was left standing for the purpose of throwing more water into the excavated channel, and to serve as a guide to pilots. With the same intention, those parts of the dam running out from the shore to the channel, above and below, were left in their places. Above the dam some rock, broken by the chisel in the year previous, was dredged up, and also a small patch below the dam was chiseled and removed by dredge.

The "Little Sycamore" dam was also standing, and this also had to be dredged up, and the rock upon which it rested chiseled off, and a clear channel given to navigation.

At "Big Sycamore" dam the obstructing cribs at the head and side of the dam, together with the largest portion of the dam, were removed, and a good entrance to the channel above and below obtained thereby.

In the month of September, chisel and dredge had finished their work, and the following quantities of rock were estimated to have been removed:

At Campbell's Chain............................	858.12 cubic yards.
At Sycamore Chain............................	245.18 cubic yards.

This was the last excavation undertaken by the firm of Case & Co.

On the 1st of October Brevet Major General J. H. Wilson was relieved from duty as general superintendent of the Rock Island Rapids improvement, and this office assigned to your charge. In the same month Brevet Major C. J. Allen was transferred to the office of General Raynolds, and ordered to St. Louis, Missouri.

Under your superintendence new bids for improving these rapids were received, and on the 16th of October the lowest bidder, Mr. Elliott Harroun, was awarded the contract, and the same signed in the latter part of November.

As the season had advanced so much that the commencement of work at Smith's Chain (the next important chain) seemed not advisable, the improvement of this chain was postponed till the spring of 1871. In the month of January, 1871, the new contractor, Mr. Elliott Harroun, died, and his heirs and partners prayed to be released from the contract. This was granted to them, and on the 13th of May new advertisements for proposals were published. On the 19th of June the lowest bidder, Mr. J. J. Dull, was awarded the contract, which was signed July 11, 1871.

You are aware, colonel, that the former contracts were silent concerning the payment or non-payment for the "below-bottom" excavation. This caused a great deal of trouble with the contractors, and was a source of unforeseen expense to the Government. To avoid in future similar misunderstandings, you ordered the following paragraph to be inserted in the advertisement for new proposals:

> The grade for the bottom excavation is a plane 4 feet below low water of 1864; any excavation below said grade, occasioned by stratification or carelessness of workmen, will not be paid for.

According to this sentence any controversy will in future be removed, and the work on the part of the Government be facilitated. In former years the contractors did not care to keep the plane of grade, knowing that they would be paid for the "below-bottom" excavation, but now they may go as deep as they please, no more than the amount of rock found by careful and minute measurements and calculations upon the plane 4 feet below low water will be paid for to the contractors.

Soon after signing the contract, Mr. J. J. Dull commenced building a coffer-dam at Smith's Chain, 900 feet by 250, and excavation in the pit is now in a fair state of progress.

At the present time a second coffer-dam, at the so-called "opening of Smith's Chain," has been commenced, and will be completed in about one week. Two chisels are working on a patch above the first-mentioned coffer-dam.

It is proposed, as soon as the work at Smith's Chain is finished, to improve, before the close of navigation, patches between Sycamore and Smith's Chains, also patches near Crab Island and St. Louis Chains.

The engineering work done by me and my assistants, Messrs. C. J. Pauli and C. H. Beuck, was as follows:

A dispute about quantities of rock to be paid to contractors at certain chains having arisen between them and the Government, a claim of the contractors, Case & Co., is now pending in the United States Court of Claims, and nearly my whole time, together with that of my assistants, has been occupied in investigating the grounds of this dispute and reporting upon it.

During the months of August and September, 1870, extensive soundings, which your predecessor deemed necesssry, were made for this investigation.

These soundings were made—

1. In the channel at Duck Creek Chain.
2. In the upper part of channel at Moline Chain.
3. In the channel at Campbell's Chain.
4. In the channel at Sycamore Chain.

Soundings were also taken on patches above Sycamore Chain and on Smith's Chain to complete the maps made in 1867; 4,300 theodolite-bearings, 4,300 compass-bearings, and 68,000 soundings were taken on these various places.

The soundings of Campbell's, Moline, Duck Creek, and Sycamore Chains were platted with a protractor in the month of October on common paper, and afterward, during the winter months, calculations of bearings and plottings of soundings by abscissas and ordinates were undertaken, together with a minute report, investigation, and various calculations concerning the above-mentioned dispute.

In the beginning of June this work, together with the following maps, was completed:

One large map of Smith's Chain, (sound-map,) 79.2 inches=1 mile, 4¾ by 6 feet.

One large map of Smith's Chain, (sister-map,) 79.2 inches=1 mile, 4¾ by 6 feet.

One large map of Sycamore Chain, (sound-map,) 84.48 inches=1 mile, 4 by 7 feet.

One large map of Campbell's Chain, (sound-map,) 79.2 inches=1 mile, 4 by 7 feet.

One large map of Duck-Creek Chain, (sound-map,) 84.48 inches=1 mile, 4¾ by 7 feet.

One large map of Sycamore Chain, (sound-map,) 84.48 inches=1 mile, 4 by 7 feet.

One large map of Campbell's Chain, 79.2 inches=1 mile, 4 by 7 feet. (Last two on common paper.)

One map of Sycamore Chain, showing "below-bottom" excavation, 84.48 inches=1 mile.

One map of Campbell's Chain, showing "below-bottom" excavation, 79.2 inches=1 mile.

One map of Duck Creek Chain, showing "below-bottom" excavation, 84.48 inches=1 mile.

One compilation, showing surface of excavation according to survey in the pit, and according to sounding-maps at five different chains.

One map of Sycamore Chain, showing "below-bottom" excavation.

One map of Campbell's Chain, showing "below-bottom" excavation.

One map of Campbell's Chain, showing "below-bottom" excavation.

One map of Sycamore Chain, showing profiles in the channel.

One map of Campbell's Chain, showing profiles in the channel.

One map showing places to be improved for the final completion of the work at the rapids.

One general map of the Rock Island Rapids.

One field-map of Smith's Chain, 79.2 inches=1 mile, 5 by 3 feet.

One field-map of patches between Sycamore and Smith's Chains, 84.48 inches=1 mile, 5 by 3 feet.

One tracing of the map of Smith's Chain.

Several sketches attached to certain reports of the year 1870.

Besides these maps, the force of the office was engaged in preparing the evidence in relation to certain claims filed in the Court of Claims against the United States, a work which occupied four months.

All of which is respectfully submitted.

E. F. HOFFMAN,
Civil Engineer Assistant.

Colonel J. N. MACOMB,
Corps of Engineers, U. S. A.

Abstract of proposals for work for the improvement of the Rock Island Rapids of the Mississippi River, received at the United States Engineer's Office, Rock Island, Illinois, on June 19, 1871, *according to advertisement dated May* 13, 1871.

No. of bid.	Name and residence of bidder.	Name and residence of guarantor.	Smith's Chain—6,579 cubic yards.		Patches between Sycamore and Smith's Chains—2,632 cubic yds.		St. Louis Chain—974 cubic yards.		Crab Island Patches—1,700 cubic yards.		Winnebago Island Patches—1,980 cubic yards.	
			Rate.	Amount.	Rate.	Amount.	Rate.	Amount.	Rate.	Amount.	Rate.	Amount.
1	J. J. Dull, Harrisburg, Pa	George Williams and A. Hosmer, Keokuk, Iowa.	$10 35	$68, 092 65	$11 00	$28, 952 00	$16 00	$15 584 00	$11 50	$19, 550 00	$14 00	$27, 720 00
2	Willard Johnson, Fulton, N. Y	John W. Pratt and Abraham Howe, Fulton, N. Y.	16 25	106, 908 75	17 00	44, 741 00	14 00	13, 636 00	15 00	25, 500 00	16 50	32, 670 00
3	Willis S. Nelson, Fulton, N. Y	do	20 00	131, 580 00	18 00	47, 376 00	22 00	21, 428 00	20 50	34, 850 00	23 00	45, 540 00
4	C. G. Case, Fulton, N. Y	George M. Case and J. H. Turner, Fulton, N. Y.	14 60	96, 053 40	14 65	38, 558 80	12 75	12, 418 50	12 25	20, 825 00	12 25	24, 255 00
5	Reynolds, Saulpaugh & Co., Rock Island, Ill.	P. L. Mitchell and William Eggleston, Rock Island, Ill.	18 00	118, 422 00	21 00	55, 272 00	22 00	21, 428 00	19 00	32, 300 00	21 00	41, 580 00
6	F. D. Van Wagenen, Rock Island, Ill.	G. J. Emery and E. A. Hempstead, Rock Island, Ill.	15 50	101, 974 50	16 50	43, 428 00	13 00	12, 662 00	14 00	23, 800 00	14 00	27, 720 00

Abstract of proposals for work for the improvement of the Rock Island Rapids of the Mississippi River, &c.—Continued.

No. of bid.	Name and residence of bidder.	Name and residence of guarantor.	Opening at Smith's Chain—1,877 cubic yards.		Lower Chain—2,000 cubic yards.		Average price per cubic yd.	Aggregate.	Remarks.
			Rate.	Amount.	Rate.	Amount.			
1	J. J. Dull, Harrisburgh, Pa	George Williams and A. Hosmer, Keokuk, Iowa.	$14 00	$26, 278 00	$13 00	$26, 000 00	$11 96	$212, 176 65	No witness to signatures of guarantors; lowest responsible biddder.
2	Willard Johnson, Fulton, N. Y	John W. Pratt and Abraham Howe, Fulton, N. Y.	20 00	37, 540 00	19 00	38, 000 00	16 85	298, 998 75	No witness to signatures of guarantors.
3	Willis S. Nelson, Fulton, N. Y	do	21 00	39, 417 00	25 00	50, 000 00	20 86	370, 191 00	Do.
4	C. G. Case, Fulton, N. Y	George M. Case and J. H. Turner, Fulton, N. Y.	14 80	27, 779 60	9 25	18, 500 00	13 44	238, 390 30	
5	Reynolds, Saulpaugh & Co., Rock Island, Ill.	P. L. Mitchell and William Eggleston, Rock Island, Ill.	21 00	39, 417 00	17 00	34, 000 00	19 29	342, 419 00	
6	F. D. Van Wagenen, Rock Island, Ill.	G. J. Emery and E. A. Hempstead, Rock Island, Ill.	16 00	30, 032 00	9 00	18, 000 00	14 58	257, 616 50	Do.

Abstract of proposals for work for the improvement of the Rock Island Rapids of the Mississippi River, received at the United States Engineer Office, Rock Island, Illinois, on the 15th day of October, 1870, according to advertisement dated September 12, 1870.

Number of bid.	Name and residence of bidder.	Name and residence of guarantor.	Smith's Chain, 7,653 cubic yards.		At Crab Island, 1,735 cubic yards.		St. Louis Chain, 900 cubic yards.		From Campbell's Chain to Duck Creek Chain, 471 cubic yards.		Moline Chain, 1,000 cubic yards.		Lower Chain, 2,694 cubic yards.		Average price per cubic yard.	Aggregate.
			Rate.	Amount.	Rate.	Amount.	Rate.	Amount.	Rate.	Amount.	Rate.	Amount.	Rate.	Amount.		
1	Epraim Owen, Keokuk, Iowa......	Guy Wells and William Timberman, Keokuk, Iowa.	$18 00	$137, 754 00	$18	$32, 130	$15	$13, 500	$20	$9, 420	$14	$14, 000	$14	$37, 716	$16 85	$244, 520 00
2	James Caldwell, Fulton, New York.	Charles J. De Graw and John H. Woodin, Fulton, New York.	12 00	91, 836 00	14	24, 990	16	14, 400	18	8, 478	15	15, 000	13	35, 022	13 08	189, 726 00
3	F. D. Van Wagenen, Fulton, New York.*	D. P. Stratford and Amos Woliver, Fulton, New York.	15 40	117, 856 20	12	21, 420	12	10, 800	11	5, 181	11	11, 000	11	29, 634	13 50	195, 891 20
4	Elliot Harroun & Co., Fulton, New York.†	S. W. Wheelock and Charles M. Lobdell, Moline, Illinois.	14 50	110, 968 50	8	14, 280	8	7, 200	8	3, 768	8	8, 000	8	21, 552	11 43	165, 768 50
5	Reynolds, Saulpaugh & Co., Rock Island, Illinois.‡	P. L. Mitchell and Cornelius Lynde, Rock Island, Illinois.	17 00	130, 101 00	19	33, 915	22	19, 800	25	11, 775	21	21, 000	18	48, 492	18 27	265, 083 00

* Signatures of guarantors not witnessed. Proposals addressed to Colonel J. N. Macomb.

† Signatures of guarantors not witnessed—on both copies. Proposals handed in at 12 o'clock, but envelope not marked "Sealed proposals," as required. One copy of bid in due form.

‡ Signatures of guarantors not witnessed. No certificate to reliability of guarantors.

H 6.

Preservation of Falls of St. Anthony.

MINNEAPOLIS, MINNESOTA, *July* 22, 1871.

COLONEL: In accordance with your orders of the 14th ultimo, I have the honor to submit the following report of works carried on by me under your directions for the preservation of the Falls of St. Anthony, during the year ending June 30, 1871.

The plan which you instructed me to carry out was as follows: To make the coffer-dam around the head of the St. Anthony Falls tunnel-tight, and then proceed to clear the débris out of gorge in the sandstone through which the water from the river broke into the tunnel, the débris to be cleared out to the bottom, and the sides sloped, and occasional transverse channels to be cut in the sides and across the bottom, and then to be filled with good clay and gravel puddled up to the limestone ledge, forming the bed of the river, and a permanent wall of masonry to be built out from the west bank of Nicollet Island, commencing at a point above the place where the gorge entered the sandstone, and across the gorge near the head; thence along on the river side of the cavity, nearly parallel with the westerly side of Nicollet Island, keeping on the limestone ledge, (see tracing herewith;) to surround the first and second breaches into the tunnel, and join on to Nicollet Island on the easterly side, the wall to be built above high-water mark, and the space between the wall and island to be filled up on top of the puddle until it is above the top of the wall, and then to be covered with riprap.

I commenced on the 9th of August, 1870. From that time to the 20th of September I worked a small force, closing up the leakage in the coffer-dam. In the mean time I was procuring releases from the St. Anthony Falls Water-Power Company, and owners of Nicollet Island, and parties owning interests in Hennepin Island, to permit the United States, by its engineers and employés, to enter upon said island and the banks of the river adjoining, and in the bed of the river, to construct such works as you might authorize me to erect, or any other works deemed necessary by you for the preservation of the Falls of St. Anthony, and to release the United States, its engineers and employés, from every claim for damages which might be supposed to ensue from the construction of aforesaid works, and to permit the United States to have, free of cost, all earth or rock on said islands or elsewhere, near the falls, belonging to any of the aforesaid parties. I then commenced clearing the débris out of that part of the gorge designated on the accompanying plan, (see tracing herewith,) as the first breach into the tunnel. I cleared it out about 8 feet in depth, and found back-water to such an extent as to preclude my going any further in that direction till I had built a coffer-dam, to close the water away from the upper end of the platform of timber which had been built as a temporary protection to keep the water out of the second breach into the tunnel, and to secure a chance to make a drain through the mass of rock and material that had fallen down. I commenced a coffer-dam at the southwesterly angle of the coffer-dam already constructed, and shown on the plan as the old coffer-dam, around the first breach into the tunnel, extending it down into the river nearly parallel with the westerly bank of Nicollet Island, leaving room enough between that and the island to remove the limestone ledge over the cavity caused by the washing out of the sandstone when the water broke through from the river into the tunnel, and also room to build a permanent wall of masonry outside of this cavity, as provided for in your plans. I constructed the dam of timber cribs, usually 20 feet long, 16 feet wide, and 14 feet high, and sunk them into the water by loading them with stone, keeping them close to each other while sinking, and in a line as near as possible in the strong current I had to contend with. I extended the dam down stream 353 feet, then turned a right angle, and continued the dam eastward toward the St. Anthony shore, leaving a space of about 160 feet between my dam and the old St. Anthony dam, for the water to flow into the mill-pond from the main channel of the river, my dam crossing the timber-platform over the second breach, and inclosing the upper end of it, which was the part where the principal leak occurred. I extended it in an easterly direction 152 feet, thence extending up stream 217 feet, and joining on to the east side of Nicollet Island. Before I had fully completed this last part of the dam, the St. Anthony saw-mills burned down, thus removing the necessity for drawing water from the main channel of the river, and as they had to construct a temporary dam from the east of Nicollet Island to the St. Anthony shore, thus closing the water out from that side of the island, I continued the dam, from the point where I turned to run easterly, down 166 feet in the same direction as the first part that I had built, and joined it on to the old St. Anthony dam, west of the Tuttle shingle-mill, removing the ballast from that part of the dam I had built out across the second breach, and used it to fill the last section, extending down to the St. Anthony dam. I also built about 4 feet on top of the river-side of the old coffer-dam around the first breach.

I completed this part of my work about the 20th of December, making total length of dam built 887 feet in the autumn of 1870, 313 feet of it to be moved on account of change of programme, caused by the burning of the St. Anthony mills, and topping up 246 feet of old dam. About the middle of April I commenced and moved that part of the dam which was extended across the second breach, commencing at the east side of Nicollet Island, and running down stream about 40 feet east of the second breach, and joining it to the old St. Anthony dam, 120 feet east of where the dam, built in the fall previous, joined it, making 430 feet of dam rebuilt this spring. Total length of coffer-dam, inclosing first and second breaches into the tunnel and cavity between, 1,268 linear feet; deducting 264 feet of old dam, which was in place when you took charge of the work, leaves 1,004 lineal feet built, capable of sustaining a head of water from 12 to 16 feet. The dam was built of timber-cribs sunk in from 6 to 12 feet of water, and well loaded with broken stone, planked on the river side with 2-inch plank. I built and rigged three derricks for handling stone, and commenced building the permanent wall around the upper breach into the tunnel, commencing on the westerly bank of Nicollet Island, above the gorge, extending out to within about 25 feet of the gorge, leaving a space across the gorge till I could get the water out so as to clear it out from the bottom. I commenced building, and extended the wall down on the westerly side of the gorge, extending the foundations nearly down to the first coffer-dam extending out from the westerly bank of Nicollet Island to the coffer-dam on the outside of the first breach. I also built a barge, and purchased one for bringing clay down the river, with which to make the puddle for filling the gorge. I get the clay on the bank of the river, about two miles above the works. There were 1,100 yards of clay and about the same amount of gravel brought down last fall, using the clay to puddle above the wall extending out from the bank of Nicollet Island to the gorge, and using the gravel to tighten up the coffer-dam.

I received your orders of April 12, 1871, on the 14th instant, and commenced building the coffer-dam from the east side of Nicollet Island to join the old St. Anthony dam 120 feet east of the point where the coffer-dam was joined to the same last fall, as described above. I then commenced clearing out the débris from the gorge at the place I had left to cross with my permanent wall of masonry. My pump worked well, and kept the pit clear, and everything worked favorably till I had reached within 2 feet of the bottom of the gorge. On the 21st of May a leak commenced in the pit that I was excavating for my wall, in the soft stratum of sand in the bottom of the gorge, the water coming in under the coffer-dam and passing through among the loose stone in the bed of the river to such an extent as to prevent me from prosecuting my work at that place. I at once filled up the pit I had opened, and commenced filling out on the earth embankment, inclosing the coffer-dam around the head of the gorge, to close the leak. The water was so diffused passing through the broken stone forming the bed of the river, over which the coffer-dam and embankment were built, that I was not able to determine the exact place where the water came under the dam. I extended the embankment on the outside into the river and up stream from 60 to 100 feet, letting it lap over on the limestone ledge about 35 feet. On top of the embankment I piled up broken stone 5 feet high, making a very heavy, and, it seemed to me, secure protection against any breaking in of water from the river. I then commenced clearing the débris out of a section 50 feet long at the lower end of the first breach, intending to go to the bottom at that place and build a wall of masonry across the gorge, and puddle up a sufficient distance to make a secure dam, then go back and commence at the head of the gorge, and make another effort to clear it out and put in my wall of masonry, having the above wall for protection in case of accident. After getting this place cleared out to within about 2 feet of the bottom, the water broke in, coming along on the bottom, on the westerly side of the gorge. I at once tried to find the place where the leak came in through under the head of the coffer-dam. After hunting about two days, I found a place in the bed of the river, about 20 feet outside of my embankment, inclosing the coffer-dam. The usual depth of the water in the river at that place was 14 feet, while, for a space about 3 feet across, the water was 20 feet deep. I at once ran out an embankment from the one built previously, and, in closing over the deep place, the leak stopped, so that there was much less water running through the tunnel than at any previous time. It appears that this leak occurred by the water coming in under a stratum of the sandstone under the embankment, thus preventing the material in the embankment from falling in, to choke up the place through which the water passed.

I am now engaged in clearing out a place at the head of the gorge, preparing to go down and close it up at that place. As soon as I can get this closed successfully against leakage, I shall push the work of clearing out and filling up the gorge with all the vigor possible.

I have a large quantity of stone quarried and dressed—I estimate sufficient to complete 300 feet of wall; and if I am as successful as I hope to be in closing the head of the gorge at the place where I am now at work, I shall be able, with the present appropriation, to permanently close up the tunnel as far as the foot of Nicollet Island this season. I regret exceedingly that we have met with difficulties of such a nature as to prevent my getting the gorge closed up and permanently sealed before this.

Notwithstanding our difficulties and disappointments, I think that we can congratulate ourselves that the precautions taken to prevent the water breaking into the tunnel, at the time the leaks occurred, have been such as to prevent any damage to the tunnel or adjoining property.

I remain, very respectfully, your obedient servant,

FRANKLIN COOK,
Engineer in local charge of work for the preservation of the Falls of St. Anthony.

Colonel JOHN N. MACOMB,
Corps of Engineers, U. S. A., Engineer in charge of surveys and improvements of the Upper Mississippi River, &c., Rock Island, Illinois.

SUPPLEMENTARY REPORT.

Preservation of the Falls of St. Anthony.

MINNEAPOLIS, MINNESOTA, *July* 22, 1871.

COLONEL: On the night of the 3d of July, my watchman found the tunnel filling with water. I immediately went to the works and found the water coming in from below all of our works; the gorge was full of water to the top of the ledge forming the bed of the river. I found that it came into the tunnel at some place between the first and second breaches. (See the accompanying tracing.) I could not find the place where the water came in from the river until about five o'clock in the morning. It was found running under the bed-rock in the river on the easterly side of Nicollet Island, near the middle of the channel, immediately under one of the large piers that were put in for a coffer-dam by the St. Anthony Falls Water-Power Company a year ago last spring, at the time they attempted to shut the water out of the tunnel after it had broken through their plug at the foot of the second breach. The pier was placed in the river so that the upper end of it rested on the sand-rock, and the down-stream end on the lime-rock, in place. After planking up the dam to stop the water from passing, it commenced running under this pier, so that it excavated a very deep cavity in the sandstone immediately under the limestone.

This summer, during the low water in the latter part of June, when the saw-mills were running on the new St. Anthony dam, they drew the water down in this part of the river, so that it made a very strong current under these piers, which, no doubt, washed deeper into the exposed sand-rock beneath, thus permitting the water to come in direct contact with a very soft layer in sand-rock strata, which is usually found about 13 feet below the limestone, the water finding its way through this soft stratum into the tunnel at about the same place where the first break from the westerly side entered. I at once collected my men together, and built a temporary dam from the head of Nicollet Island to Boom Island, this being the channel through which the water passed into the channel on the east side of Nicollet Island and the St. Anthony mill-pond. By the evening of the same day I had completed the dam, turning all the water on the west side of the island, thus leaving the St. Anthony mill-pond dry. I found the chasm through which the water had passed to be 16 feet wide and 8 feet deep from the ledge to the débris in the bottom. Another new feature in the case is, that at the lower end of the old tunnel it became so choked up with the débris that the water found its way through a new channel into the main river, coming out under the ledge about 50 feet below the apron on the westerly side of Hennepin Island.

In order to protect this new breach from being washed out in case of freshet, I commenced at once to build a coffer-dam out from the easterly side of Nicollet Island, and running down near the center of the channel of the river, and joining on to the coffer-dam which I built this spring, extending out from the easterly shore of Nicollet Island, inclosing this new breach into the tunnel. I expect to complete it so as to let the water into the St. Anthony pond next week.

I remain, very respectfully, your obedient servant,

FRANKLIN COOK,
Engineer in charge of work for
Preservation of the Falls of St. Anthony.

Colonel JOHN N. MACOMB,
Corps of Engineers, U. S. A., Engineer in charge
of Surveys and Improvements on the Upper
Mississippi River, &c., &c., Rock Island, Illinois.

ROCK ISLAND, ILLINOIS, *July* 31, 1871.

GENERAL: In laying before you this supplemental report of Mr. Franklin Cook, civil engineer, assistant in local charge of the United States work of preserving the Falls of St. Anthony, I would remark that at the urgent request of the principal parties at the Falls, owners of the water-power, and others interested in the result of our operations, I spent several days between the 8th and 20th instants in a careful examination of the work as carried on by my assistant, and in consulting with civil engineers and practical railroad constructors and others whom I was requested to meet, from all of which I am convinced that we have thus far followed, and are following, the best plan that has been devised for stopping the tunnel and preserving the Falls, and whilst we have met with new difficulties and unexpected delays, as reported to you in my letters of 11th instant and since, I still feel that there is ground to hope for success in the critical undertaking intrusted to us.

All of which is respectfully submitted by your obedient servant,

J. N. MACOMB,
Colonel of Engineers, U. S. A., Gen. Supt. U. S. work
for Preservation of Falls of St. Anthony, &c., &c.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

H 7.

UNITED STATES ENGINEER OFFICE,
Rock Island, Illinois, June 30, 1871.

COLONEL: I have the honor to make the following report of work done on the substructure of the Rock Island bridge, during the year ending June 30, 1871.

On the 1st of July, 1870, the work stood as follows: The Davenport shore abutment was finished, with the exception of the backing of the bridge-seat. The island shore abutment was finished, with the exception of a small portion of the coping and backing of the bridge-seat. A coffer-dam for the pivot masonry of the draw-pier was nearly pumped, and a coffer-dam for the lower starling of the draw-pier was about finished ready for pumping. The embankment for the Davenport wagon-approach was nearly finished, and its slopes were protected by a dry wall. This wall had not been carried up to its full height, however, and the extreme high water of April, 1870, overflowed it, causing a slight wash in the embankment and settling of the wall.

During the year the following work has been done: Piers Nos. 1, 2, 3, 4, upper starling, lower starling, and pivot masonry of draw-pier, have been entirely built. The Davenport railroad abutment has been built up to the street grade, and the island railroad abutment has been entirely built, with the exception of the coping and step-stones of the wing-walls. The dry slope-wall of the Davenport wagon-approach has been re-laid, and a slight excavation has been made for the island wagon-approach.

The timber protection connecting the three detached pieces of masonry of the draw-pier has been entirely built.

Amount of masonry laid in the river during the year.

Pier No. 1, 512 cubic yards; built by Harvey & Livesey.
Pier No. 2, 685 cubic yards; built by Government.
Pier No. 3, 539 cubic yards; built by Government.
Pier No. 4, 647 cubic yards; built by Government.
Upper starling and rest-wall of draw-pier, 1,263 cubic yards; built by Government, with the exception of 58 cubic yards, built by Harvey & Livesey.
Lower starling and rest-wall of draw-pier, 488 cubic yards; built by Harvey & Livesey.
Pivot masonry of draw-pier, 1,010 cubic yards; built by Harvey & Livesey.

Amount of masonry laid on land during the year.

Davenport railroad abutment, 347 cubic yards; built by Harvey & Livesey.
Island railroad abutment, 214 cubic yards; built by Harvey & Livesey.

Dry-slope wall laid.

Davenport approach, 397 yards; built by Government.

Earth embankment.

Davenport approach, 996 yards; built by Government.

Earth excavation.

Island approach, 679 yards; made by Government.

Timber and crib work.

Draw-pier, 469,360 feet timber, board measure; built by Government.

Materials received during the year.

2,118	cubic yards of stone.
2,393	barrels cement.
1,104	cubic yards sand.
469,360	feet timber, board measure.
23,160	pounds iron for sheathing piers.

41,387 pounds iron for doweling, tie-rods, washers, bolts, &c., for crib of draw-pier.
276 cubic yards of rubble and macadam stone.
201.3 cubic yards riprap in lower starling of draw-pier.
495.3 cubic yards riprap in upper starling of draw-pier.
696.6 total in starlings.
1,668 cubic yards in the crib of draw.
2,364.6 total cubic yards of riprap in draw-pier.

The contractors for building the piers, Messrs. Harvey & Livesey, showed great want of energy or capacity in carrying on their work, and it was finally found necessary to take it out of their hands, which was done on the 8th of October, 1870.

From the beginning of the year up to that time, they had put only three pieces of masonry in the river, viz: Pier No. 1, and the pivot masonry and lower starling of draw-pier. On land they had partially built the two railroad abutments. On the 8th of October we took the work in our hands, and on December 10 had built piers Nos. 2, 3, 4, and the upper starling of draw-pier, all of which stand in deeper water and on much more difficult foundations than any the contractors had built. A coffer-dam for the last pier, No. 5, was also constructed and pumped out, but owing to the existence of a thick bed of boulders and gravel at the site of this pier, the presence of which was not known, the coffer-dam was badly broken in pumping, and the lateness of the season, December 13, rendered its abandonment necessary. The river was full of ice the next day.

In order to facilitate the washing away of the dams no longer needed, the tie-rods in the upper stringers were removed about the last of December.

I hoped and expected that the moving ice and swift current during the high water of the spring would carry the dams away entirely. This was especially desirable at No. 5, as it is necessary to get this dam out clean before constructing another one. Unfortunately this dam held fast, while most of the others were washed away.

A steam-dredge is now at work removing it, and I hope in a few days to commence the construction of the new one.

About the time of taking the work out of the hands of Messrs. Harvey & Livesey, they presented to you a paper protesting against your action, and making certain statements about the work. This paper is full of misrepresentations. Soon after they presented to the Secretary of War a petition asking to be reimbursed in the sum of about $240,000, claiming it was due for their work and the damage they had sustained at the hands of the Government. This petition was referred to me, and I was directed to prepare copies of all papers relating to the dealings of this office with Messrs. Harvey & Livesey, and also to make a statement of facts in the case. These papers were made out and forwarded.

I was called upon, together with yourself and several assistants in the office, to give our testimony before a United States commissioner in a suit which Messrs. Harvey & Livesey had brought against the Government to recover damages.

It is unnecessary here to say more than that the claims of Messrs. Harvey & Livesey are outrageous and unwarranted.

RECAPITULATION.

All the masonry work of the bridge has been completed, with the exception of pier No. 5, and about 365 cubic yards to finish the four abutments.

The timber protection of the draw-pier has been finished, and also the main part of the approaches.

The work was much delayed during the year, principally by the tardiness of the contractors, but it was taken out of their hands on the 8th of October, 1870, since which time it has progressed much more rapidly.

Very respectfully, your most obedient servant,

AMOS STICKNEY,
Captain of Engineers, U. S. A.

Colonel J. N. MACOMB,
Corps of Engineers, U. S. A., Rock Island, Illinois.

UNITED STATES ENGINEER OFFICE,
Rock Island, Illinois, August 28, 1871.

COLONEL: In obedience to your instructions, I have the honor to make the following report upon the progress made in the construction of the superstructure of the Rock Island bridge, up to June 30, 1871.

General specifications for the superstructure of the bridge having been issued in May, 1870, bids were received for the same on the 6th of July, 1870, from the following firms:

Detroit Bridge and Iron Works	$354,500
Keystone Bridge Company	403,000
L. B. Boomer, Chicago	399,920 432,100
Baltimore Bridge Company	452,090 459,784
Kellogg, Clarke, & Co	519,000 539,000 552,000 554,000

The drawings, strain-sheets, statements of weights, &c., accompanying the bids were carefully examined and considered, and a report made thereon by me, recommending the adoption of the design as proposed by the Baltimore Bridge Company. This report, together with one from General Warren, to whom the subject had been referred, was sent to the Secretary of War, who, on the 23d of September, approved of the recommendation that the contract be awarded to the Baltimore Bridge Company for $459,784. A contract was accordingly entered into for three spans, one 366-foot draw, one 260-foot span, and one 220-foot span, that being about the amount of work that could be carried on with the available funds then on hand.

The work upon the two fixed spans and part of the draw was carried on at Phœnixville, Pennsylvania. The turn-table, engine, and hydraulic jacks, for supporting and turning the draws, were in course of construction at St. Louis. On the 30th of June all the iron for the 260-foot span, and part of the 220-foot, had been fabricated, examined, and tested, and was then being shipped. The machinery for the draw was nearly all finished.

On account of the heavy masses of material, novel shapes, and nicer workmanship required for the spans of this bridge, it has taken much longer to get the material out than had at first been estimated. The contract with the Bridge Company was accordingly extended until the

15th of October, when it is expected that the three spans mentioned above will be completed.

There will then be left five spans (three double-deck, and two single-deck) to be erected. It is confidently expected that the entire bridge will be finished by the first of March, 1872.

Very respectfully, your obedient servant,

W. H. H. BENYAURD,
Captain of Engineers.

Colonel J. N. MACOMB,
United States Corps of Engineers,
General Superintendent Rock Island Bridge.

H 8.

ROCK ISLAND, ILLINOIS, *May* 15, 1871.

GENERAL: I send to you to-day by express a box containing the maps and report of Mr. Gorham P. Low, jr., civil engineer, assistant in charge of the survey for a ship-canal from Hennepin, on the Illinois River, to Watertown, on the Mississippi River, some eight miles above here, showing a length for the canal some sixty-five miles, and a feeder some thirty-eight miles. This report was completed by Mr. Low, and presented at my office during my absence on a tour of duty to Phœnixville, or it should have been forwarded at an earlier day.

I cannot say that I agree with Mr. Low in the conclusion that, in case of the construction of the canal, "the counties and cities immediately benefited by the work would relieve the Government from any expenditure for damages," but the great cost of the ship-canal will probably prevent the Government from immediately undertaking the work, especially in view of the good water communication between the lakes and the Mississippi by the Illinois River improvement now in progress. That part of the report giving estimates for a commercial canal between Hennepin and the Mississippi River will be of interest to the canal commissioners of the State of Illinois, and to that part of the community whose interests would be promoted by such a line of communication; and as the ship-canal survey afforded the data for such an estimate, I authorized it to be appended to the report upon the ship-canal survey.

The box now sent by express contains the following papers: Mr. Low's manuscript report to me, XXII pages, and the tabular statements, and six sheets of maps mentioned in the report.

All of which is respectfully submitted by your most obedient servant,

J. N. MACOMB,
Colonel of Engineers, United States Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

Report on a canal route between the Illinois River, near Hennepin, and the Mississippi River, near Rock Island, with a navigable feeder from the Rock River, at Dixon, April 10, 1871.

ROCK ISLAND, ILLINOIS, *April* 10, 1871.

COLONEL: I have the honor to submit the following report upon the examinations and surveys of a route for a ship-canal between the Illinois River, near Hennepin, and the Mississippi River, near Rock Island, with a navigable feeder from the Rock River at Dixon.

The party having taken the field September 5, 1870, I took charge of the surveys on the 19th of that month, by order of Brevet Major General Wilson, United States Army. Early in December the field-work having been completed, most of the party were discharged, and the remainder have since been engaged in preparing the accompanying drawings and estimates. I was ably assisted upon the surveys and office-work by Mr. Albert Millet, civil engineer, in charge of the transit party, and Mr. Lovell Swisher, civil engineer, in charge of the leveling.

The drawings submitted are as follows:

Sheet A.—Map and profile of proposed route from the Illinois River to Devil's Slough.

Sheet B.—Map and profile of proposed route from Devil's Slough to the Mississippi River.

Sheet C.—Map and profile of proposed route for feeder.

Sheet D.—General map of proposed canal and feeder.

Sheet E.—Proposed lock for ship-canal.

Sheet F.—Proposed lock for commercial canal.

It will be observed from the maps that the main line of survey differs in many places from the proposed line of canal. In such cases cross-sections and side-levels were taken, sufficient to furnish data for profiles on both lines. According to original instructions all calculations and estimates for excavation, locks, &c., were to be based on the dimensions recommended for the enlarged Illinois and Michigan Canal. I have, therefore, estimated for a ship-canal section 160 feet in width at the water-line, and 7 feet deep, with slopes of 2 to 1; and for locks 350 feet long and 75 feet wide. I also submit estimates for a commercial canal of smaller dimensions. At various portions of the line it is proposed to reduce the width of the ship-canal section in deep cutting to 100 feet on water-surface. This width will allow the passage of tows of barges as large as can enter the locks, while the reaches thus narrowed are not long enough to seriously delay them when meeting each other. The cost of widening at any time will be no greater, and probably less, than at first construction. The estimates have been made accordingly. To protect the banks of the ship-canal from the action of waves from passing steamers, I have proposed the construction of low retaining-walls, to be built into the slopes and extending 1 foot below and 18 inches above the surface of the water, as being more economical in respect to material than riprapping. As such a wall would be built only after the opening of the canal to navigation, I have estimated it at $5 per cubic yard, laid without cement.

In the design for ship-canal locks shown on sheet E, the gates are similar to those designed by General Wilson for the locks at Keokuk. The water is admitted into the lock through a valve-platform and archways in the upper miter-sill wall, and is discharged through valve-openings in the lower gates. As the transportation of stone and other material to the sites of most of the locks will be very expensive, this plan of construction is proposed as requiring the smallest amount of masonry. As a rule, the foundations of the locks will not be expensive, and probably only locks Nos. 1, 2, and 3 will need bearing-piles. Lock-masonry is estimated at $21 per cubic yard. As the canal is designed for the passage of steamers of large size, estimates have been made for swing-bridges of 75 feet openings, and placed high enough to allow the passage under them of ordinary barges and horses. On the feeder, no protecting walls, and only ordinary bridges, have been estimated for.

The eastern division of the work, extending from the Illinois River to the junction with the feeder at Devil's Slough, will be 25.86 miles in length; will contain nineteen locks of an aggregate lift of 207 feet; will require three railroad and thirteen common draw-bridges, and sixteen culverts. It will be the most expensive portion of the line to construct, and is estimated to cost $5,779,277 24, or $223,483 26 per mile.

The dam across the Illinois River at Henry, in process of construction by the State of Illinois, will form a pool extending to the southern terminus of the Illinois and Michigan Canal. By reference to sheet A, it will be seen that, starting from this pool in the Illinois River opposite Hennepin with two locks of 8-foot lift each, the proposed line runs across the bottom-land to the Bureau Valley Mills, where it crosses the Peoria branch of the Chicago, Rock Island and Pacific Railroad, and continues up the southerly side of the valleys of Bureau and West Bureau Creeks, a great portion of the way being under the bluffs and requiring the construction of only one bank. On the seventh mile, counting from the Illinois River, the line becomes parallel with the Chicago, Rock Island and Pacific Railroad, and continues between that road and the bluffs to the crossing of the Chicago, Burlington and Quincy road on the eighteenth mile and near Pond Creek Station. It there passes under both roads and runs over the summit-level to the junction with the feeder-line at Devil's Slough, about three miles north of Sheffield. Between locks Nos. 15 and 17 it will be difficult to make room for an independent channel for Pond Creek, and it might be advisable to construct ponds and weirs instead of the regular canal-section, thus forming a common channel for canal and creek. A slight change in the location of the railroad at this place would save much earth-work in the construction of a canal.

The bottom-lands of Bureau Valley are composed of sand and gravel with a covering of from 1 to 3 feet of soil and clay. The underlying material would probably give ready passage to water, and I have, therefore, endeavored to avoid cutting into it by making the upper clay the bottom of the proposed work, where practicable. The bluffs are composed of clay mixed with some gravel, and will furnish excellent material for the construction of water-tight banks. The swamps crossed upon the summit-level have from 4 to 6 feet of vegetable soil over a substratum of good clay. Immediately west of lock No. 19, and on the summit-level, quicksand is found 19 feet below the surface, and probably exists at about the same depth for some distance along the line.

The western division extends from the junction with the feeder to the Mississippi, near Watertown, and is 39.45 miles long, making the total length of the main canal 65.31 miles. It will require the construction of nine locks, with an aggregate fall from the summit to the Mississippi of 92 feet, three railroad and thirteen common draw-bridges, twelve culverts and aqueducts, and one dam. The cost of the division is estimated at $4,429,566 13, or $112,283 05 per mile.

From the junction the line runs nearly due west until it crosses Mud Creek, near Annawan, 3,800 feet north of the railroad. From this point several lines were run. One, nearly parallel with the railroad, and intended to pass through the town of Geneseo, was found to require a long cut of 30 feet, besides other heavy work, and was abandoned. Another line, crossing Spring Creek near the railroad and bearing off from thence toward Green River, was also rejected. The route adopted crosses Spring Creek about two miles north of the railroad, passes through the cross-roads on the line between sections 13 and 14, Geneseo Township, and joins the valley of Green River near the covered bridge. A more direct line between the junction and this point would place the canal too low to easily cross Mud Creek and other streams flowing into Green River from the south. From the covered bridge the canal would continue down the valley, lying most of the way under the low bluffs and becoming parallel with the railroad at the fifty-fourth mile; then passing through the town of Mount Oakley it would cross Green River on an aqueduct 200 feet long, run through a deep cut at Colona and encounter Rock River at the sixtieth mile. It is here proposed to raise the water of that river 7 feet by a dam placed a short distance above the railroad bridge, and to connect the canal by a lock with the pool thus formed. From here the line of canal will be almost direct to the Mississippi River near Watertown, five miles above Moline and eight miles above the city of Rock Island. Another route between this point and the Mississippi is naturally presented in Rock River itself. In this connection I would refer to the maps and report of the survey of Rock River, made in the fall of 1866 by James Worrall, civil engineer, under the direction of General Wilson. By adopting this route, the dam above the railroad bridge would be superseded by one corresponding to dam No. 21 of the proposed Rock River improvement, which would be located about half a mile below the mouth of Green River. The estimated cost of that portion of the Rock River improvement extending from the railroad bridge at Colona to the city of Rock Island, and provided with locks 150 feet long and 30 feet wide, is, according to the above-mentioned report, $902,283 45. The estimated cost of a cross-cut canal between Rock River at the railroad bridge and the Mississippi near Watertown, and having locks 350 feet long and 75 feet wide, is, by my estimate, $979,005. An examination of the prices upon which the Rock River estimates were based, shows that at present rates the total would be somewhat less. But there would still be a large margin in favor of the cross-cut canal when it is considered that the estimates by that route are for locks of over four times the capacity of those proposed for the other line. I therefore felt justified in neglecting to make an instrumental survey and detailed estimate of the Rock River route.

For the supply of the canal it will be necessary to bring water from the Rock River at Dixon to the summit-level north of Sheffield. The amount of water flowing in Bureau Creek was, at the time of the survey, not more than 50 cubic feet per second at any available point, and West Bureau Creek was nearly dry.

On the eleventh mile water could be admitted from Bureau Creek, but as the chief demand is at the summit-level, the lockages and leakage of the gates at that level would probably supply all the lower reaches. The length of the main canal between the Illinois and Rock Rivers, or that portion to be be supplied through the feeder, will be sixty miles. The length of the feeder will be 38.12 miles, making a total of about ninety-eight miles. The loss from evaporation and leakage I assume at 2.5 cubic feet per second per mile, or 245 cubic feet per second total loss. Assuming the number of passages over the summit-level as ninety in twenty-four hours, corresponding to one hundred and eighty lockages, 656 cubic feet per second will be required to supply the locks, making the total demand for the canal and feeder 901 cubic feet per second.

We were fortunate in making a careful measurement of the amount of water flowing in the Rock River at a time, October 11, 1870, when, according to the residents of that city, the river was at its lowest known stage. The amount of water at that date was found to be 2,446 cubic feet per second, which, under the present available head of 7 feet, gives, theoretically, 1,943 horse-power. To economize earth-work upon the feeder line and summit-level, it will be advisable to raise the crest of Dixon Dam 2 feet, thus increasing the head of water to 9 feet. After deducting 901 cubic feet per second for the canal, there will be available for manufacturing purposes in the dryest times 1,545 cubic feet, or 1,578 horse-power under the 9-foot head. The loss of power at this point, after allowing for the increased height of dam, will be equal to 365 horse-power, or 18.8 per cent. of that at present available. The loss at Sterling not being compensated for by a higher dam, will be equal to 36.8 per cent. of the present power.

The dimensions of the feeder section recommended and estimated upon are, 140 feet in width at the water-surface, 112 feet on the bottom, and 7 feet deep, giving an area of 882 feet and calling for a velocity of nearly 1.1 foot per second to pass the necessary supply. The slope given to the bottom of the feeder, as shown on the profile, is a little over one-tenth of a foot to the mile, or 4 feet in thirty-eight miles. The banks, both for the main canal and feeder, are to be built 3 feet above the surface of the water, and to be 12 feet wide on tow-path, and 7 feet wide on berm. It is proposed that the head-gates and guard-locks at Dixon be placed at the lower end of the water-power canal, which would require enlargement. From thence the feeder would be located near the left bank of Rock River for 10.5 miles, at which distance, 1.75 miles beyond the crossing of the Chicago and Northwestern Railroad, it leaves the valley of the river and takes a southerly course across the prairies. For a great portion of the way in Rock River Valley, the construction of only one bank will be necessary.

Four miles from Dixon the river takes an abrupt turn under a steep ledge of rock, and the work at this point will be expensive and require considerable protection.

Guard-gates and a waste-weir have been estimated for at the creek crossed on the tenth mile. After leaving Rock River the general direction of the line is somewhat south of west, and requires no cutting of more than 17 feet until just beyond the twenty-sixth mile, when it cuts through a narrow ridge 30 feet above grade. Immediately before reaching this point, and on the twenty-fifth mile, the bottom of the canal will be from 3 to 7 feet above the level of the marsh. From the twenty-sixth mile the course is nearly straight to New Bedford, where Green River will be crossed on an aqueduct 200 feet long and 13 feet above the low-water level. The fall in this river between this point and the covered bridge north of Geneseo is 35.5 feet. Between New Bedford and the junction considerable earth-work will be required. The very long slopes of the ground lying between Rock River and the junction make it impossible to select the best route by reconnaissance, and it would be necessary to run several lines before a final location could be made. The lateness of the season prevented any such examination, but in case of future action I would recommend that between the twenty-third and twenty-ninth miles, and between the thirty-second and thirty-fourth, surveys be made west of the line shown upon the maps.

The material found upon the line is mostly clay and soil, the ridges being composed of sand. No protecting wall has been estimated for on this portion of the work. The feeder will be 38.12 miles in length, will require two railroad and fourteen common bridges, eight culverts and aqueducts, one guard-lock, two waste-weirs, and the raising of Dixon Dam, and will cost $2,270,849 90, or $59,571 08 per mile.

The estimated cost of the whole work appears from the following summary:

Eastern division......	25.86 miles..................................	$5,779,277 24
Western division.....	39.45 miles..................................	4,429,566 13
Feeder division.......	38.12 miles..................................	2,270,849 90
Total	103.43 miles..................................	12,479,693 27

The details of the above are given in the tabular estimate for ship-canal accompanying this report.

Locks of the size contemplated would admit a steamer and tows of barges capable of carrying 2,000 tons.

The supply of water calculated upon will be sufficient for one hundred and eighty lockages per day under the most favorable circumstances, that is, with an equal amount of travel each way, and the locks always full to descending and empty to ascending boats. With the travel in one direction only, the supply of water would limit the number of lockages to ninety per day. Neither of these extremes is to be expected in practice, and taking the mean of the two cases, the number of possible lockages can safely be counted at 135. This would correspond to sixty-seven passages over the summit level which, at 2,000 tons each, will give a capacity of 134,000 tons in twenty-four hours. Should the travel be wholly in one direction, this would be reduced to 90,000 tons per day. Should more than one hundred and eighty locks full per day be used, the level of the water in the summit-level would be lowered and the velocity in the feeder be increased.

The objections to the construction of a canal of the size contemplated in the foregoing portion of this report are, its immense cost, the interest on which, at 6 per cent., would amount to $748,781 60 per annum; the large amount of water to be taken from Rock River, to the injury of the manufacturing interests; the quantity of water necessary to the lockage of boats should they present themselves singly, or in small tows; and the expense of tending and keeping in repair a work of such magnitude.

The proposed enlargement of the Illinois and Michigan Canal, and the lock and dam in course of construction in the Illinois River, contemplates the passage of iron-clad gun-boats between the Gulf and the lakes; but since boats suitable for use on the Gulf and lakes would be unfit for the Upper Mississippi, it is inferred that this project is for commercial purposes only. This being the case, a smaller canal would probably be better suited to the situation, both from its reduced cost and the smaller amount of water required by it.

The facts in relation to the large canal having been brought to your notice, you verbally directed me to report and estimate upon a canal of smaller section. I have, therefore, proposed a canal section 60 feet wide at the water-line, and 6 feet deep, and having slopes of 2 to 1, with locks 150 feet in length and 21 feet in width. These dimensions correspond to those adopted by J. O. Hudnutt, civil engineer, in his estimates for a canal over nearly the same route, based upon surveys made in the summer of 1866.

The line recommended for this work corresponds nearly with that shown upon the maps for the larger canal, and the elevation of its water-surface and bottom are indicated by broken and dotted lines upon the profile. Upon the main portion the bottom of the channel corresponds with that before proposed, making its water-line 1 foot lower. Composite locks have been estimated for, and in number, location, and lift are similar to those already enumerated. No swing-bridges, or inside protecting walls will be necessary. The amount of water required for this canal is estimated as follows: For evaporation and leakage, 1.33 cubic feet per mile per second, or 130 cubic feet per second for canal and feeder; for two hundred lockages in twenty-four hours, 87 cubic feet per second, making a total demand from Rock River at Dixon of 217 cubic feet per second. With a feeder 50 feet wide and 6 feet deep, with slopes of 2 to 1, the sectional area will be 228 square feet, and the velocity required to the above quantity 0.95 feet per second. To obtain this velocity through the above section, it will be necessary to give to the bottom of the feeder an inclination of 0.16 feet to the mile, or 6 feet fall from Dixon to the junction with the main line.

The eastern division, from the Illinois River to the feeder, is estimated to cost $1,467,202 44, or $56,736 37 per mile. The western division, from the feeder to the Mississippi, $1,429,708 50, or $36,241 03 per mile. The feeder, $1,002,811 70, or $26,306 71 per mile, making the total for the whole work $3,899,722 64, or $8,579,970 63 less than for the larger canal. A tabular detailed statement of this estimate accompanies this report. The surveys were made wholly for the purpose of locating a canal 160 feet wide, and the narrower section would probably admit of following the bluffs more closely and thus effect a large saving of earth-work.

The locks proposed for this work will admit boats of a capacity of 280 tons. At three locksfull to a boat, 18,760 tons could be passed daily.

Freight could be brought in tows from points on the Upper Mississippi to the canal, and then by horse-power through this canal to the Illinois River, and through the Illinois and Michigan Canal to Chicago without breaking bulk. I have not considered it any part of my duties to report upon the commercial advantages of this project, nor have I at hand sufficient data for the purpose. I have endeavored to make the estimate sufficiently high, and am of the opinion that the amount stated above would fully cover the cost of construction. The amount of earth-work would probably be somewhat reduced upon a final location. No estimate has been made for land damages, but it is presumed that the counties and cities immediately benefited by the work would relieve the Government from any expenditure under that head.

Very respectfully, your obedient servant,

GORHAM P. LOW, JR.,
Civil Engineer, Assistant.

Colonel JOHN N. MACOMB,
Corps of Engineers, U. S. A., Rock Island, Illinois.

APPENDIX I (1.)

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, July 28, 1871.

GENERAL: In compliance with the regulations, I have the honor to submit this my annual report of operations upon "the improvement of the Mississippi, Missouri, and Arkansas Rivers."

On the 12th of July, 1870, I reported in Cincinnati, under orders to relieve Colonel J. N. Macomb, Corps of Engineers, of the duties under his charge, and to remove the office to this city. Colonel Macomb had, previous to my relieving him, completed the surveys previously under his charge, the only duty in progress at the time being the improvement of the Mississippi, Missouri, and Arkansas Rivers, for the prosecution of which a fleet of four snag-boats and one dredge-boat were turned over to me.

These boats were all, at that time, lying at Mound City, Illinois, where they were undergoing extensive and thorough repairs, which were nearly completed. I at once visited Mound City and inspected the fleet, gave instructions for at once taking the field, and then returned to Cincinnati, receipted to Colonel Macomb for the funds and property belonging to the work, made arrangements for shipping the office records and furniture to this city, then came here and made preparations for opening an office as directed.

Field operations had been conducted, for some time previously, under the direction of Captain C. R. Suter, Corps of Engineers, under whose immediate charge the repairs and improvements of the several boats had been in progress. I found all the boats were being put in splendid order, and I receipted to Colonel Macomb for five boats better fitted for the duty for which they were designed than any which had ever been in use.

I availed myself of the experience of Captain Suter in getting the fleet started, and under his immediate direction the whole fleet was under way by the 28th of July, their destination being the Mississippi River, above this city, and the Missouri from Omaha to its mouth.

OPERATIONS IN THE MISSOURI RIVER.

The fields first assigned to the several snag-boats were as follows:

The S. Thayer, between Omaha and St. Joseph.

The R. E. De Russy, between St. Joseph and Lexington.

The S. H. Long, between Lexington and Eureka.

The J. J. Abert, between Eureka and the mouth of the river.

Under date of August 6, 1870, I was ordered by the Department to dispatch a snag-boat at once to White River. This order rendered a change of programme necessary. The R. E. De Russy, not having yet reached her field of operations, was withdrawn from the Missouri and sent to White River; the S. Thayer was withdrawn from above St. Joseph and assigned to the Missouri between Lexington and St. Joseph, thus preventing any work above St. Joseph.

On the 14th of August, the dredge-boat Octavia, after having been up the Mississippi as far as Keokuk and deepened all the bars between this city and that point, went into the Missouri to aid the snag-boats in their operations, and to provide against the danger of their being caught in this stream by low water and thus rendered unavailable for service in the lower rivers.

Operations were continued in the Missouri until the 1st of November, when the several boats were withdrawr and assigned to duty in the Lower Mississippi and Arkansas Rivers.

The details of operations in the Missouri are included in the table of work done, herewith submitted, marked A. Such a table, however, gives little idea of the benefit conferred upon commerce, nor can this be fully appreciated by any excepting those immediately interested in navigation. Four years ago, or before the snag-boats commenced their operations, the navigation of the Missouri was so dangerous that boats did not attempt to run at night; now they always do so. This change has been brought about entirely by the operations of the snag-boat. The saving in time in a round trip from this city to Saint Joseph and return cannot be estimated at less than four days, or in money at less than $1,000. There is of course a proportionate saving on shorter trips, and as not less than two boats daily leave this city for the Missouri River during the season of navigation, it will be seen that, in running-expenses alone, a benefit has been conferred upon the commerce of this one stream far exceeding the amount of the total appropriation for the three rivers. To the saving in running expenses we must also add the saving in risk, or rate of insurance, to form an estimate of the real benefit conferred. The saving in the expense of running boats on the river does not benefit the owners only; competition at once brings about a corresponding reduction in the rates of freight, so that the saving inures directly to the benefit of shipper and producer.

It is very desirable that the snag-boats should be able to take advantage of the annual spring rise to get into the Missouri River, and be on hand to commence work as soon as the stream is low enough. To do so they should be ready to start for the field by the 1st of April. They should extend their field of operations at least as far as Sioux City. To clear the stream of the annual deposit of snags and logs would require about six months' work. My estimate for this duty is therefore as follows:

Running-expenses of four snag-boats, six months each, in all twenty-four months, including proportionate amount of repairs, at $5,000 per month, $120,000.

OPERATIONS IN THE MISSISSIPPI RIVER.

The dredge-boat Octavia left this city for the Upper Mississippi on the 3d of August, and proceeded up the Mississippi to Keokuk. She dredged the channel at the following points:

Piasan Bar, four miles above Alton; Hat Island, thirty-five miles above Alton; Worthington Point; Armstrong's Landing, four miles above Hannibal; Scott's Landing, five miles above Louisiana; Thomas's Chute; Two Branches Island, and left the stream in good navigable condition.

The shoals in the Mississippi River being composed of light shifting sand, it is not expected that the dredging done will be a permanent benefit. The next rise in the river washes in the sand and leaves the channel in about the condition it was when the dredging commenced. The only remedy for this is to keep a boat at all times ready for service—watching the changes in the stream—and as soon as the shoals begin to obstruct navigation, to have them visited, and, by means of the dredge, conduct the water into a single channel of sufficient depth for the purposes of commerce. This will be required as far down as the mouth of the Ohio, and it is doubtful if a single boat will be able to accomplish the work. This question will be tested the present season, as it is proposed to keep the Octavia at work between Keokuk and Cairo as long as the limited appropriation will admit. To do so throughout the year would require an appropriation of $60,000 for this work alone.

On leaving the Missouri River the snag boat J. J. Abert was assigned to that portion of the Mississippi between the mouth of the Missouri River and Memphis, Tennessee. The S. H. Long was directed to work between Memphis and the mouth of the Arkansas, and up the Arkansas to Little Rock, Arkansas. The "R. E. De Russy" was, as has been stated, sent under special orders to White River. She was directed, on leaving that stream, to clear the Mississippi of snags as far as Vicksburgh.

The appropriation for the improvement of the Mississippi, Missouri, and Arkansas rivers being only $150,000, or one-half the estimated cost of running the whole fleet throughout the year, it was deemed advisable to lay up the dredge-boat on her leaving the Missouri River, and expend the money it would cost to run her in continuing the operations of the snag-boats. The "Octavia" was accordingly laid up at Mound City, November 19, 1870.

The snag-boats Abert and De Russy were directed to continue their operations so long as was practicable, giving themselves time to reach Mound City, lay up, and pay off and discharge their crews by the 31st of December.

At the time the snag-boats were withdrawn from the Mississippi, the river, as far down as Memphis, was full of running ice, which for the time nearly suspended navigation. The boats, however, reached Mound City by the date specified, having done good service—the stream being comparatively free from snags—although the operations of the snag-boats in the Mississippi have not produced so marked a change in navigation as has been done in the Missouri, for in this stream the boats have always ventured to run at night; still the benefits to commerce have been marked and decided, the stream being, as all admit, in a better condition than ever before.

To meet the wants of commerce on this stream, and render the navigation as free from danger of snags as is practicable, not less than three snag-boats should operate in it each year, for not less than eight months each, or twenty-four months' work of one boat, which, at $5,000 per month, would cost $120,000.

OPERATIONS IN ARKANSAS RIVER.

The snag-boat S. Thayer, on leaving the Missouri River, was ordered to proceed to Little Rock, Arkansas, for the purpose of operating in the Arkansas River above that point. She was detained in this city about a week to make some necessary repairs, and started November 11 for her field of operations. The unusually cold weather and high water interfered materially with her operations. She succeeded in reaching Illinois Bayou, doing good service. The instructions given her were, to work up the stream as far as practicable during the time the balance of the appropriation would permit her being kept in the field, the 31st of January being fixed as the date when it would be necessary for her to be at the rendezvous at Mound City and the crew discharged.

The snag-boat S. H. Long, on leaving the Missouri, was assigned to the field between Memphis, on the Mississippi, and Little Rock, on the Arkansas, with instructions similar to those given the Thayer, to be at Mound City by the end of January. She entered Arkansas River December 15, and accomplished all that could be expected of her in the limited time she had to operate. A fair channel was left in the stream, but more time must be devoted to the Arkansas if we desire to render the service to commerce which snag-boats are capable of giving. Four boats could be profitably employed for five months of each year, or twenty months in all, which would cost, at $5,000 per month for each boat, $100,000.

The necessity of more snag-boats, for operating in this extended field, has been so often urged that it can hardly be necessary to say more on the subject. A still greater want, however, is appropriations large enough to enable the boats we have to do all the good they are capable of doing. At present they can be kept in commission but about six months. The remainder of the year they must remain idle owing to the want of funds. The want of economy by such a course is too palpable to require pointing out. The obstructions to navigation exist, we have the boats for removing them, but the means are furnished for keeping these boats running "but half the time."

In a report forwarded from this office in October last, the snag-boats were spoken of as furnishing aid to commerce on western rivers, similar to that of light-houses on the ocean or lake. This comparison may seem out of place at first sight, but the more it is studied the more just it will appear. The most expensive light-houses in the country have been built to mark dangers to navigation. Half a million of dollars has not been thought too much to mark a single reef of rocks, while the annual expenses of keeping up such a light amounts to thousands. This is right, for life as well as property is at stake, and liberal appropriations are, as they should be, made almost without challenge. Why, then, should not the General Government extend similar fostering care to the commerce of our western rivers? If the obstructions were such that they could be marked by expensive light-houses, to be kept up by large appropriations, the means would be forthcoming almost as soon as asked for. But when these obstructions are such that their location cannot be fixed, (thus making them the more dangerous,) and are so numerous that to mark them with lights would be simply impossible, and yet, although they can be readily removed with the appliances on hand, the means are furnished to keep these appliances at work but a part of the time, the policy is akin to that which would put out all our light-houses for half of each year.

Of the snag-boats now on hand, but one is suited for operations in the smaller streams during low water, their draft being too great. Two additional boats should be provided for this duty. They should be built of iron, and to draw not over three feet when fully equipped and ready for work. The construction of such boats would cost $100,000 each, or for the two, $200,000.

On the 3d of April, 1871, I forwarded to the Department a report of a board of officers appointed by me to examine and report upon the condition of the several boats of the fleet, and to present estimates of the repairs required. I was notified by telegram that the report was approved, and was directed to commence the proposed repairs. Instructions to that effect were at once given.

On taking the boats out of the water, all of them were found to be in a worse condition than was anticipated, and consequently more time was consumed in making the repairs. This is not in the least surprising when we consider the duty performed by these boats. The force required and applied to remove a large tree with roots attached, imbedded twenty or more feet in the soil, is not shown by any table of "weight of snags" which may be given. We know only that our heaviest chains (the iron in the links being 2¼ inch diameter, with each link braced) have been frequently broken. Then, again, the "butting beam" must stand the blow of a boat weighing over 1,000 tons, moving eight or ten miles an hour, being brought to a stand almost instantly. No wonder that, as yet, no construction has been firm enough to withstand such usage without frequent and expensive repairs. Not until we build of iron can we hope to get sufficient strength to meet the requirements for any length of time.

The repairs on the several boats were completed, and they resumed operations in the field as follows:

United States snag-boat S. Thayer, May 31, 1871; United States snag-boat. J. J. Abert, June 13, 1871; United States dredge-boat Octavia, June 17, 1871; United States snag-boat R. E. De Russy, July 9, 1871; United States snag-boat S. H. Long, July 18, 1871.

PROPOSED OPERATIONS THE PRESENT SEASON.

The amount of the appropriation for the present fiscal year being no greater than that for the last, field operations cannot be continued for any longer time. The assignment of the boats for the present season is the same as for the last. It having been found expedient, as far as practicable, to have each boat work in the same locality successive seasons, it is proposed that the main features of the season's operations shall be similar to that of the last, the difference being in this: That the dredge-boat Octavia will confine her operations to the Mississippi, between Keokuk and Cairo, unless she should be required to aid the snag-boats in getting out of the Missouri.

Small appropriations having been made for improving the Ouachita, St. Francis, White, Black, and Little Red rivers, it is proposed to send boats into these streams after they shall have completed their operations under the appropriation for the improvement of the Mississippi, Missouri, and Arkansas rivers.

I shall aim also to have the boats of the fleet examined and repaired as soon as they are withdrawn from the field, and lay them up in good order, that they may be ready for active operations as soon as the means for again running them may be available.

RECAPITULATION OF THE FOREGOING ESTIMATES.

For the improvement of Mississippi River:	
For running-expenses of four snag-boats, six months each, twenty-four months, at $5,000 per month	$120,000 00
For running-expenses, including repairs of one dredge-boat throughout the year, twelve months, at $5,000 per month.	60,000 00
For the improvement of Missouri River:	
For running-expenses of four snag-boats, six months each, twenty-four months, at $5,000 per month..............	120,000 00
For the improvement of Arkansas River:	
For running-expenses of four snag-boats, five months each, twenty months, at $5,000 per month.............	100,000 00
For additional facilities for improving Western rivers:	
For the construction of two double-hull snag and wrecking boats, at $100,000 each..........................	200,000 00
Total estimate	600,000 00

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

I (2.)

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, February 17, 1871.

GENERAL: I have the honor to forward herewith the report of Captain C. J. Allen of a survey "at Alton and St. Louis Harbor, Mississippi River, between Alton and the mouth of Maramec River," made under my direction.

As I have been in daily communication with Captain Allen during the progress of this survey and the preparation of his report, and we have made it a matter of frequent discussion, our views have been brought so nearly in accord as to render it necessary for me to do little more than to forward the report with my approval.

I am satisfied that in dealing with a stream of the size and of the peculiar characteristics of the Mississippi, the only safe method of proceeding is to follow nature as closely as practicable. When we find the river inclined to do what we would like to have done, to aid it by all the means at our command. When the contrary is the case, to interpose obstructions as speedily as practicable, and do the least that will effect the object in view.

In the case of Alton Harbor, the desire is to get as much deep water in front of the city as practicable. The most natural method of effecting this object is to close the channel west of Ellis Island. A comparison of the map of survey in 1868, made under the direction of H. C. Long, esq., civil engineer, with the map of the present survey, indicates that this process has already commenced, though the data on map of 1868 is too meager to show exactly what change has taken place. If this passage could be closed at low water only, all that is requisite would be effected. The low and comparatively cheap dam proposed by Captain Allen would probably be all that would be required.

If a greater proportion of water passed to the westward of Maple Island the tendency would be to lessen the effect of the scour on the east bank opposite the mouth of the Missouri. This passage is now obstructed by snags; hence, if our principles are correct, they should be removed. Before this survey was commenced I visited the mouth of the Missouri and made a personal examination of the state of affairs in that locality. The scour of the bank, immediately opposite the junction of the two streams, is still going on rapidly, the rate of course varying with the relative stages of the rivers. If the Missouri is low when the Mississippi is high, the action is little or nothing. I visited the head of Mobile Chute and found a considerable quantity of water making its way through the piles of logs and drift-wood obstructing that passage. The map accompanying the report of 1843 shows this passage as the main channel of the Missouri in 1829. The thought at once suggests itself, Why not restore the condition of affairs that then existed? The work can be done by one of our snag-boats in about two months. Its execution would be legitimate under the general appropriation for the improvement of the navigation of these rivers; for, aside from any effect which we might hope for elsewhere, all boats navigating the Missouri would use this passage if it was open.

The free passage of the water through this channel would have an effect, opposite the present mouth of the Missouri River, similar to lowering the water in that stream, and consequently to diminish the scour where it is now most rapid and dangerous; and, taken in connection with the removal of the obstructions west of Maple Island, we would have reason to hope for a result by which the dangerous action now going on would be effectually checked. In short, the changes proposed seem to me only restoring the condition of affairs as they existed forty years ago, and are to my mind so obvious that I propose, in case a sufficient appropriation is made to put the snag-boats in commission the coming season, to remove these obstructions without asking for a special appropriation.

The dike on the Grand Chain has failed entirely to deflect the river or any portion of it into Cabaret Slough, or to any appreciable degree diminish the scour in Sawyer's Bend.

In 1843 the water in Cabaret Slough was from 6 to 9 feet in depth. At present the slough is filled with sand to from 4 to 8 feet above the level of low water, and of course no water passes through it at that stage. The change in the regimen of the river in this locality since the Grand Chain dike was proposed, is so marked and radical as to almost lead to the conclusion that the effect of the dike has been directly the reverse of that which was expected, but we have no data to show the condition of the head of the slough previous to the building of the dike, nor do we yet know fully what may be there. No borings have ever been made to determine the position of the bed-rock, or any other obstruction which may effectually prevent the washing out of this channel. We know that in "Pocket Chute," and above it on that side of the river, there are at present a large number of snags visible; as to how many there are that are invisible we are ignorant. These snags are not in the channel, hence are not obstructions to the navigation, and, as the snag-boats have had more than they could do to keep the channel clear, no work has ever been done in this locality. There is of course a possibility that during some high stage of the river Cabaret Slough may again be washed out, but if we could increase the volume of water passing through Pocket Chute the scour in Sawyer's Bend would evidently be diminished. The conclusion is, that the snags in that locality should be removed. I therefore regard Pocket Chute and the east side of the river above it as far as the head of Cabaret Slough as one of the most important localities in which our snag-boat could work. But with our limited means, not having enough boats to keep the channel clear, even if kept at work all the time, and the appropriation not being sufficient to keep the boats in commission throughout the year, I hesitate to employ the means at command, except to improve the main channels.

Every day's study of the duty under my charge increases my sense of the important service which may be rendered by the snag-boats, if the means are provided to render them as efficient as practicable.

Aside from the good which can be done by keeping the channel free from snags, I am satisfied that they could do much to remedy the evils which have so long been at work, and which are still threatening the important interests at St. Louis, Alton, and vicinity; but they have never worked a day for the direct purpose of doing so. This portion of the river has been treated like every other portion, all labor being confined to the removal of the worst obstructions from the channel, and thus render all the aid in our power to the general commerce of the river. But here is a case where important interests demand that the quantity of water flowing through passages not used for commerce should be increased. The removal of the snags in these passages would certainly help to effect that object, and might be all that was required. It seems to me useless to argue further the propriety of furnishing the means to keep these boats constantly at work.

The necessity of a more careful examination of the river, to include a minute survey from bluff to bluff, and borings to determine the position of the rock in all places where improvements are proposed, is so obvious that I am surprised that nothing of the kind has been done. Nearly a million of dollars has been expended by the General Government and city authorities of St. Louis on "improvements" in St. Louis Harbor, and yet, with the exception of those for the bridge and water-works, we do not know that any borings have been made. Dikes have been built which have entirely disappeared. Stone has been thrown into the river without the least idea of the amount which would be required to effect the object in view; no general system of improvement has been adhered to; every engineer has done what "seemed good in his own eyes," and all, it would seem, for the very simple reason that no one knew what effect the work he proposed or had undertaken would produce. I indorse most heartily Captain Allen's recommendation of an appropriation for a *thorough* examination of this section of the river.

Very respectfully,

W. F. RAYNOLDS,
Lieutenant Colonel Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

ST. LOUIS, MISSOURI, *February* 3, 1871.

COLONEL: I have the honor to submit herewith my report of the survey and examination of the Mississippi River from Alton, Illinois, to the mouth of the Maramec River in Missouri.

Upon reporting to you for duty, I was assigned, by verbal orders on the 16th of November last, to the charge of this survey and examination, then in progress under Mr. S. E. McGregory, civil engineer and assistant, who had commenced the work early in October. My first duty under this order was to find the party, which I accomplished by the 20th of November, coming up with them about a mile above the head of Cabaret Island, to which point their surveys had extended. Mr. McGregory had made a complete triangulation of the river and banks from Hop Hollow, about two and one-half miles above Alton, and had run a transit-line on each bank, connected with his points of triangulation. The harbor of Alton had been sufficiently sounded to enable the shoals and sand-bars to be projected, as well as to define other obstructions to navigation.

Thorough observations had been made at the mouth of the Missouri River to determine the extent of the abrasion of the Illinois shore opposite the mouth; and the examination of the channel west of Mobile Island, and generally known as Mobile Chute, as ordered by you, had been made. A line of levels had been run along the Illinois shore, from the mouth of Wood River below Alton to a point a short distance above the village of Madison; thence up the river, on a line parallel to the river bank, a short distance from it, for about a mile; thence across the valley of Long Lake, along the top of the dike erected there, to the bluffs. I was instructed to make as thorough an examination of the river, and particularly of the harbors of St. Louis and Alton, as the means at our disposal and time would admit of; also to ascertain, as far as possible, the changes that had taken place since the surveys of former years; to ascertain the extent to which the banks had suffered abrasion, to determine the weak points, and to report the general condition of the river throughout the portion under survey.

As it was then late in the season, with a prospect of cold weather setting in and closing up the work before it could be finished, I determined to reorganize the survey, so as to get over as much ground as possible before cold weather and ice should set in. I therefore directed the party then at work to continue the triangulation down to the river Des Peres, the southern boundary of the city of St. Louis, and organized another party to run a transit-line from the Des Peres to the Maramec River, with instructions to locate all prominent points, bends, and islands, and to note the track of steamers whenever practicable, the party above to connect with this party. Meanwhile I organized a hydrographic party, and placed it under the immediate charge of Mr. H. L. Koons, civil engineer, to sound the harbor of St. Louis, from the foot of Cabaret Island to the lower city limits, operating from the base-lines established by the shore parties.

By the middle of December the ice had formed in the river, materially interfering with the work. The sounding was therefore discontinued, and the field-parties, excepting those engaged in finishing the triangulation and topography, ordered in. The latter work was continued, with many interruptions from inclement weather, until the latter part of January, when field-work ceased. From the city of Alton to the Maramec River, a distance of forty-one and a half miles measured along the channel of the river, the Mississippi winds through the valley, bounded on the east by the highlands known as Kaskaskia Bluffs, and the Missouri Bluffs on the western side. The former extend from the Kaskaskia or Okaw River, in Randolph County, Illinois, to the city of Alton, at a distance of from five to eight miles from the river; thence the range continues to the mouth of the Illinois River, the bluffs rising abruptly above the surface of the Mississippi to a height of from one hundred to two hundred feet. The opposite bank of the Mississippi, from the mouth of the Missouri for many miles up, is composed of a light, alluvial soil, rising abruptly, though to the height of but few feet above ordinary stage of water, in some places heavily timbered. In fact, for several miles the Missouri and Mississippi Rivers are only divided by a narrow tongue of land. The Missouri Bluffs are met with about four miles above the junction of the two rivers. The bluffs run nearly parallel, in general direction, with the river, alternately approaching and receding from it. From the Des Peres to the Maramec they are, in general, close to the river.

The strip of land between the Kaskaskia Bluffs and the present course of the Mississippi is known as the American Bottoms, averaging, as stated above, from five to eight miles in width. It is composed of light, alluvial soil, with some clay and sand; of very little consistency. Underneath is a stratum of quicksand. The Mississippi has undoubtedly, in the centuries that have elapsed, occupied successively every point between the Kaskaskia and Missouri Bluffs. These bottoms are subject, in many places, to overflow at medium stages of water. At high stage, particularly when the Missouri and Mississippi reach this stage at the same time, the entire bottoms are submerged. These floods create considerable damage, at times, by washing away banks; compensating partially, however, by leaving a crust of alluvium over the more stable portions. Considerable soil is also washed down from the bluffs during heavy rains. Extensive levees have been erected to prevent the incursions of floods from the Missouri and Mississippi, and to prevent the backing up of the water from Cahokia Creek. These levees form a catch-water basin during rains, the water eventually going off by evaporation, leaving the sediment to add to the soil. The bottoms throughout are intersected by minor streams, which serve to drain off the surface-water. The principal of these within the limits surveyed are Long Lake and Cahokia Creek—the former, during the dry season, a dry, narrow ravine; the latter emptying into the Mississippi near the foot of Bloody Island, opposite St. Louis, and, excepting in the rainy seasons, hardly more than a small ravine.

The river scarp on the Illinois side, throughout the whole distance surveyed, is particularly liable to wash and abrasion, and immense masses of bank cave in after every rise in the river. In fact, any slight disturbance at the foot of the scarp is followed by heavy slides of land, which is taken up by the current and transported to other points, either to form bars or islands. The banks are in many cases precipitous, from twenty to thirty feet in height; in others, low and sandy, and covered with growths of willows. On the west side, from the Missouri to the site of the new water-works at St. Louis, the banks are mainly steep, rising to the height of thirty feet above the surface of the river at medium stage of water, and of the same nature as those on the opposite side. No rock is visible in the banks from the Missouri River down, until the chain of rocks about six miles above the northern city limits is reached. From this point down no rock is met with until the vicinity of the old water-works is reached. The bed of the river throughout the distance from Alton to the mouth of the Maramec is composed of shifting sand and sediment extending down to the bed-rock. Borings made to determine the site of the St. Louis bridge, and for wharf purposes and others, show that the rock underlies this shifting bed to a distance varying from 40 to 80 feet, and even more.

Bars and shoals form in the most unaccountable manner after every rise in the river. New channels are made and old ones filled up within a few hours. It is through this portion of river, with shifting bottom and movable banks, that the survey was made, with the view of arriving at its condition and projecting plans for its improvement. From Hop Hollow to Alton the distance is about two and a half miles. Opposite Alton are two islands. The upper, what is termed by river men a tow-head, is designated in this report as Round Island. It is nearly encompassed by a sand-bar extending a considerable distance above it to within 600 feet of the Missouri shore, and below it considerably below the head of Ellis Island and out into the channel. (See map.) Ellis Island, the second island, is just below Round Island, and is about one and a half miles in length; banks high and timbered. Back of this island, and between it and the Missouri shore, is a channel called Alton Slough, averaging 900 to 1,000 feet in width. About one mile below Ellis Island is Maple Island, 2,700 feet long and heavily timbered. To the north of this, and near its head, is a small island only visible at lowest water, between which and Maple Island is the present steamboat channel. A large bar, 2,700 feet in length, extends below the foot of Maple Island

The Missouri River empties into the Mississippi about four miles below the steamboat-landing at Alton, measured along the channel of the river. Just below the junction of the two rivers is a large island and bar, called Mobile Island, about two miles long, timbered and partly cultivated, between which and the main Missouri shore is the channel known as Mobile Chute. Two miles below Mobile Island, and about eight miles below the Alton steamboat-landing, is Chouteau Island, about four miles in length, timbered and partly cultivated. Just above the head of Chouteau Island, on the Illinois shore, is the village of Madison, consisting of a few houses. In 1867 the authorities of Madison County erected a substantial dike across the upper end of the slough behind the island, making it wide enough for a good roadway on the top, and extending above high-water mark. They also connected this dike with a levee, extending east to the American Bottom levee, and west and southwest to a ridge of land on Chouteau Island, completely cutting off all passage-way for the water in this direction. The lower end of the slough is still open, admitting the water from the river at an ordinary stage. The water remaining stationary, deposits all the sediment, and in time the slough will probably fill up. The lower end is now filling up faster than the upper, so that, when the river falls below the sand-bar, at the lower end of the slough, there is left a long and narrow pond of stagnant water. During the last high water, the difference of level between the surface of the water above the dike and the surface below it was two feet, indicating very nearly the surface slope of the river at this stage from the head to the foot of Chouteau Island. The river is opposite the head of the island, 3,600 to 4,000 feet in width, increasing to 5,700 feet at the middle of the island, thence decreasing to 4,500 feet in width at its foot. The land of Chouteau Island is as high as, if not higher than, the levee on the main shore, and its crest next the slough is protected by standing timber and brush, so that the American Bottom levee, for the whole distance in the rear of this island, is protected from abrasion of the current during high water. The upper end of Chouteau Island shows an abrasion of, since 1813, between 800 and 900 feet at the widest place, gradually narrowing down to a few feet at the lower end.

Wilson's Island lies nearly directly west of Chouteau Island, nearly opposite its center, close to the Missouri shore, only separated from it by a narrow slough, a few hundred feet in width, full of logs and snags. This island, unlike all the other islands, has formed a large bar at its head, nearly five times the area of the island itself. The current in the slough has about half the velocity of that in the main channel. The main shore is protected here by a belt of timber and brush from one to three hundred feet in width along the edge of the shore. At this point the bluffs approach the river to within a distance of two to three thousand feet, the space between the foot of the bluffs and the shore being flat and subject to overflow at mean and higher stages of water.

About one mile below the foot of Wilson's Island is a ledge of rock, called the Grand Chain, extending apparently two-thirds across the river from the Missouri shore toward Cabaret Island, and entirely covered during ordinary stages of water, the main channel passing over the outer edge of the ledge, which is the lowest. Here a large stone dike has been constructed by the city of St. Louis, at a cost of $92,000, for the purpose of deflecting the water through Cabaret Slough. The effect has not equalled the expectations. The slough is rapidly filling up. At the time of my last inspection in December, when the water was at its medium stage, it could be passed over dry-shod. The current, rushing around the end of the dike, strikes the shore a short distance below it, and is wearing it away as fast as, if not faster than it did before the dike was built. The dike is correctly represented in position on Colonel Merrill's map, with the exception that the longitudinal portion is now several hundred feet shorter than there represented. This difference is doubtless due to the lower portion having sunk entirely from sight within the last three years.

Just below Chouteau Island, on the same side of the river, is Cabaret, or (as some of the old maps have it) Cascarot Island, three and one-fourth miles in length, and separated from the Illinois shore by the slough mentioned above. This slough is 1,800 feet in width at its entrance, increasing to 2,700 feet at the center, thence narrowing down to 2,500 feet at its mouth. This slough is represented on all the old maps as having about the same width as the main channel of the river. If this slough was ever the main channel of the river, it must have been so previous to the year 1813, as the surveys of that date show the channel to have been on the west side.

There are no records of surveys previous to that date. Cabaret Island originally contained about 1,460 acres, or nearly two and one-third square miles, according to the United States Land Office survey. There has been but little abrasion of its shores comparatively. It is a part of the State of Illinois, the boundary line being the center of the main channel. On Cootes and Winkelmaier's map of 1843, accompanying the report of Colonel Merrill on the harbor survey of St. Louis, there is represented a long irregular island between Cabaret Island and the Missouri shore; this island has no name, and is not shown on any of the older maps; it has probably formed within the last forty years. Some parts of it are now as high as any of the neighboring islands, and covered with a vigorous growth of willows. Between this island and Cabaret is what is called Pocket Chute. This chute is now much wider than represented on the map of 1843 referred to above.

Grand Chain dike, failing to deflect the water through Cabaret Slough, has, apparently, amongst its other effects, had the effect of widening and deepening the channel of Pocket Chute, and if the snags and other obstructions could be removed, and the channel deepened by dredging, some of the abrasion of the Missouri shore might be avoided. From the head of Cabaret Island, (or rather opposite the head,) on the Missouri shore, and extending down to the new water-works, in the upper portion of the city, is a huge bend, the concavity towards the river, called Sawyer's Bend, which is wearing rapidly.

A large bar has formed across the lower end of Cabaret Island and across the mouth of Cabaret Slough; its outer edge taking nearly the shape of the opposite shore. Eighteen miles below Alton the upper limits of the city of St. Louis are reached, nearly opposite the foot of Cabaret Island. The city front has a development of nearly thirteen miles, terminating at the mouth of the river Des Peres. From the upper city limits the towns of Venice and Brooklyn, on the left bank, are passed, as also East St. Louis, on Bloody Island, and belonging to the State of Illinois.

Below Bloody Island, and opposite the United States arsenal in Lower St. Louis, is Arsenal Island, about two miles in length. The channel passes to the west of this island, although soundings taken behind the island, on its eastern side, showed a line of deep water extending quite throughout its length.

From the river Des Pères to the mouth of the Maramec River, twelve miles measured along the steamboat channel, a succession of shoals and islands occur. More thorough examinations will be necessary upon this portion of the river before anything more definite can be stated.

The banks on the west are rocky, and approach the river closely and nearly continuously, until a short distance above the Maramec, when they travel to the west, leaving the river.

The Maramec was not traced up. Humphreys and Abbot, in their report upon the Mississippi River, describe the stream and its basin as follows:

"*Maramec Basin.*—The northern slope of the eastern portion of the Ozark Mountains drains into the Maramec River, a stream which enters the Mississippi a few miles below St. Louis. This basin is hilly in character, containing no lands liable to inundation. Its area, taken from Hutawa's sectional map of Missouri, is five thousand four hundred and seventy square miles."

At the time of our examination several large bars were formed opposite its mouth.

ALTON HARBOR.

The city of Alton, according to the last census, has a population of 11,359. The city lies partly at the foot of the high range of bluffs, spoken of in the first part of my report, and partly on a slope gradually ascending to the high range of bluffs back from the river. The levee front commences at the foot of the high range overhanging the river, running for a short distance on a line parallel to the scarp of the bluffs, thence deflecting to the east about 23°. Within this angle of deflection, and for one and one-half miles below the apex, lies a large sand shoal, entirely cutting off the levee front, excepting about 800 feet from the channel, preventing boats from landing at low stages of water. This shoal, known as Alton Bar, extends across the river about three-fourths of the entire distance, narrowing the channel between it and Ellis Island to about 1,000 feet. Behind Ellis and Round Islands (described in the first part of this report) a large portion of the river, probably one-third, discharges through Alton Slough. The bar above Round Island has been increasing of late years, and its upper end is now about 2,000 feet from the upper end of the island, extending also a considerable distance below the head of Ellis Island, running diagonally across the thread of the main channel of the river. Between the bar and Round Island, and between the latter and the head of Ellis Island, are two branches or chutes, through which a portion of the water entering Alton Slough is discharged into the main channel with considerable velocity. The map of Alton Harbor, made in the winter of 1858 and 1859, shows the current as running in the other directions, and entering the slough through the chutes.

The slough or channel is about 900 feet in width at its head, increasing to 1,250 feet at the middle, where there is an extensive shoal extending half-way across to the foot, where it narrows down to 720 feet in width. The map of 1858 and 1859 represents the main channel as passing behind Ellis Island. The recent survey shows that such is not the case now, yet a considerable depth of water exists in the slough, varying from 8 to 12 feet in depth. Our examination shows an improvement in the condition of the harbor since the last survey, made in 1858; yet another high flood may reverse the present state of affairs, and make the harbor worse than it was before. The current, as it approaches the city, seems to be parallel in direction with the general line of the banks, until about one mile above the steamboat-landing, when it is deflected to the west, and hugs the Missouri shore; the steamboat channel, however, being on the Illinois side, a portion of the discharge, as stated, enters the slough back of Round and Ellis Islands; the remainder is deflected toward the Alton landing, and thence back toward Ellis Island, creating by this means the triangular-shaped bar above the islands, and partially forming the Alton bar. One cause of the first deflection of the current toward the Missouri shore may be traced to the piles of refuse stone thrown into the river from the numerous stone-quarries and lime-kilns at the foot of the bluffs above the city. Another cause of the formation of the Alton Bar lies in the form of the levee itself, the re-entering forming a pocket for the reception of the sand deposited by the current as its velocity is diminished. Another cause, perhaps equally potent at times, arises from the conjoined action of the Missouri and Mississippi. The Missouri, entering the Mississippi below Alton, strikes the latter river at right angles to the direction of its current. The discharge of the former is always greater than that of the latter at similar stages of water, and immensely so when, as often happens, the Missouri is at its flood when the Mississippi approaches its low stage. In this case, especially, the former predominates over the latter, spreading out over the low lands, backing up considerably beyond Alton, checking the velocity of the Mississippi, and its overflow also, and resulting in the deposit of mingled mud and sand, which is not always scoured out after the subsidence of the flood. Obviously, an increase in velocity and discharge through the channel in front of the city would remedy partly if not wholly the difficulty. The increase of velocity would only be beneficial during the low stage, or after the disappearance of the Missouri flood.

Various plans have been submitted to remedy this evil; one, and the favorite plan, is to connect the head of Ellis Island with the main shore by a timber and stone dike. This, although it would have the effect of throwing the volume of water that now discharges through the slough into the main channel, seems to me to be unnecessarily expensive. Furthermore, if raised to the height to which it is proposed, it will be likely, at high water, to cause considerable scour of the lands adjoining. Revetment of the eastern bank of the island would be necessary in this case, as it would, however, to some extent, whatever plan might be followed. A line of obstructions placed along the bar above the islands, and crossing the channel between the bars and the Missouri shore, placed diagonally with the direction of the current, and closing up the two chutes between the bar and the islands, (see map,) would deflect the current to much better advantage toward the Alton landing, and probably form a bar, or increase the present bar at the head of Ellis Island, and serve in that manner to protect the upper portion of the island from wash to a certain extent. But the possibility of this being damaged or carried away by ice led me to reject this plan. Its cost I have estimated at $59,011 50; materials, brush, stone, and piles.

In my opinion, a dam raised to the height of low water should be extended across the slough from a point about the middle of the island, the exact position to be determined at the time of construction. Experience has shown that dams located about midway between the head and foot of a slough give the best results both as to scour and deposit.

The cost of such a dam, built of brush, stone, and piles, would be—

2,500 solid yards of stone, delivered in the dam, at $2 25	$5,625 00
2,500 cords of brush, delivered in the dam, at $2 25	5,625 00
200 piles, at $7 50	1,500 00
Contingent expenses, 15 per cent	1,912 50
Total	14,662 50

The above can be profitably expended during the next season. The materials can all be obtained in the immediate vicinity. The brush should be either made into rafts, and floated to the place where they are to be sunk, or made into fascines, and sunk with stone. I have not provided here for any revetment around the head and east bank of the island. The effect of the obstruction should be noted. If it is found that wear and abrasion of any portion of the island occur from the effects of the obstruction placed in the slough, it will, in my opinion, be ample time then to estimate for a protection.

STATISTICS TO ACCOMPANY REPORT.

Amount of internal revenue collected for the year ending June 30, 1870, $207,729 44.

Government building nearest to Alton, is the St. Louis custom-house.

Number of arrivals and departures from the port, for the year ending June 30, 1870 3,502. Trade of the port for the same time, 100,153 tons. Registered tonnage for sam time, 787 tons. For this information I am indebted to Mr. W. T. Miller, of the Alto board of trade.

In connection with the harbor of Alton, I would say that if the citizens would rectify their levee front, so as to include in it the greater portion of the bar, which now obstructs the landing to their disadvantage, they would not only add considerable land to the city property, but also keep up a good stage of water, and add to the improvements below the city. Any line of obstructions, no matter how temporary in construction and material, placed on the prolongation of the upper portion of the levee, which would cause a deposit of sand or other sediment, would aid in making land, and this, together with refuse stone, cinder and ashes, earth, &c., would bring the levee out to the line of deepest water.

In making this suggestion, I know nothing of local interest involved. The practice of throwing stone into the harbor along the line of quarries and kilns in the upper part of the harbor is pernicious, and should be discontinued.

MOUTH OF THE MISSOURI.

One of the greatest sources of danger to the surrounding country from abrasion of banks, lies in the action of the Missouri and Mississippi, combined upon that portion of the Illinois shore opposite the mouth of the Missouri, and directly below it. The Missouri discharging into the Mississippi, as stated in the discussion of Alton Harbor, in a direction at right angles to the direction of the latter stream, with a much greater surface-slope, and consequent velocity and discharge, preponderates greatly over the Mississippi, the controlling action varying as the stage of water in each increases or decreases.

The Mississippi is deflected from its normal course, the resultant current of the two streams bearing directly upon the banks opposite, wearing them away at a rate almost beyond belief, excepting to those who have actually watched and measured its encroachments. The resultant current strikes almost perpendicularly to the general line of the banks, the angle which it makes being greatly in excess of the angle of stability for the most favored soils. The mouth of the river in 1829, as shown by the map of the survey of 1843, was over two miles below the present opening. From some cause the old avenue has been closed, and the main body of the stream now debouches about two and a half miles above. The shore-line opposite, as indicated by the maps of the land survey of 1813, was considerably to the west of what it is now, the continued abrasion having worn off a strip of land 1,000 to 3,000 feet in width for a distance of four and a half miles measured along the banks. Comparisons of the maps of our survey with those of former years, show that marked changes have taken place in the channel of the Mississippi as well as at the mouth of the Missouri. From the lower end of Ellis Island the channel is a little to the southwest, directly toward the head of Maple Island, which it strikes with great force, wearing it away rapidly; here the channel divides, the greater body of water and the main steamboat-channel passing to the left and east of the island. By examining the records of the United States land office, it appears that Island No. 1, as there recorded, and containing 51 acres, corresponds very nearly with the position of Maple Island, which has scarcely half that number of acres. It is conclusive that they are identical, and that the dissimilarity of size and shape arises from the abrasion of the banks by the current during the fifty-eight years ttha have elapsed since the United States land surveys were made.

Island No. 2, of the same survey, lies immediately north of No. 1, and was estimated to contain 23½ acres. At the time of the survey none of this island was visible; at extreme low water a small portion of it is seen, or rather what remains of it. The channel between the two islands, originally but 200 feet wide, is now the main steamboat-channel. The examination of the records shows that these islands belonged to the present State of Illinois; consequently, the main channel was to the west of them. In the examination made to discover where the channel was at that time, there was found what appeared to be an old shore-line, beginning at a point on the western shore just below Ellis Island, and running in a southerly course toward the present channel of the Missouri River; east of this line, for one-fourth of a mile, is a low, flat bar, but little elevated above low water, with an occasional mound covered with willows, and no timber of an older growth than fifty years. In 1855 there was a steamboat-channel opened through this place during high water of the Missouri, and was much used. The only land that is elevated above an ordinary stage of water, east of the old shore-line spoken of, is a few acres on the point between the two rivers. This was probably once an island. By examining the map, it will be seen that a straight line drawn from the lower end of Ellis Island through this low place would strike the head of Missouri Chute. This line may have once been the course of the Mississippi. As before stated, the Mississippi River divides at the head of Maple Island; that part to the right and west of the island is now but a narrow slough, full of logs and snags, but the current is very rapid and evidently deepening it, and bearing toward the Missouri shore, which is wearing rapidly. The eastern channel of the Mississippi, after leaving the head of Maple Island, inclines toward the Illinois shore, striking it about one-half mile above the junction of the two rivers; from this point the current hugs the Illinois shore, uniting with the resultant current of the Missouri and the portion of the Mississippi that has passed to the west of Maple Island. I have no doubt that the channel of the Mississippi once passed to the west of Maple Island and toward the head of Mobile Island, and that the Missouri once flowed through Mobile Chute, (between Mobile Island and Missouri shore.) This chute, as shown on the map, is about one and three-quarter miles in length by 900 feet wide, at the head, gradually widening to 2,700 feet at the mouth. It is, at present, choked up with snags and logs, but the current rushes between them with great rapidity. At the lower end of the chute is a small island. Along the main shore and opposite the island is an old levee; this has been broken through in several places, and no longer serves the purpose for which it was intended. The banks are steep and yielding, and are already wearing away. Were this chute cleared of all its obstructions, and the point of land "A," (see map,) taken off, considerable of the Missouri discharge would pass through the new channel, reducing the direct discharge into the Mississippi by this means, and, consequently, bringing the resultant current near the Missouri shore, and below the point of Mobile Island. The channel west of Maple Island should be cleared of the obstructions, giving a free flow of water through it, thus aiding in bringing the current of the Mississippi nearer to the head of Mobile Island. The passage between the small island in Mobile Chute and Mobile Island should be closed up with the material taken from the chute. By excavating the lower end of the chute, so as to make it deeper than the upper, a greater inducement will be offered to the flow of water through it.

The point "A" will probably be washed away by the current. I am informed that the proprietor of the land bordering the Missouri side of the chute is not averse to losing some of his property by the "wash," as he can dispose of his timber to better advantage if the chute is deepened so as to allow boats to pass through it and land along the shore. The change in the delta of the Missouri, from whatever cause it originated, causing the current of the river to strike that of the Mississippi at an unfavorable angle, has doubtless been one cause of the change in the channel from the west to the east of Maple Island. The portion of the Illinois shore subject to abrasion is part of the American Bottom, and is here steep and high, of light alluvium, and underlaid by quicksand, rendering it easy of removal by the current, and subject to slides and caving from any disturbing cause. The bank is concave toward the river, the chord of the entire abraded portion being three and three-fourth miles. The entire abraded portion consists of two curves, gradually merging into each other, the upper curve, or the one directly opposite the mouth of the Missouri, being a 2¼-degree curve; the lower is about one-half degree curve.

During extreme high water of the Missouri, which generally occurs in June, the bottoms are entirely submerged, excepting where levees have been provided; and when the two rivers conjoin their floods, the country for miles around is under water.

It has been feared for many years that these floods would find their way into the valley of Long Lake and Cahokia Creek, and, in the course of two or three floods, eventually change the channel of the Mississippi, carrying it toward the foot of the Kaskaskia Bluffs, and, passing to the east of St. Louis, leave the city an inland town. I do not apprehend any immediate danger from this cause. A line of levels runs from the mouth of Wood River, through and across the valley of Long Lake, to the head of the dike built by the American Bottom Levee Company, showed the top of the dike to be high enough above the surface of the river to protect the portion of the bottoms below it from overflow, except in the very highest stages of the river, when everything is under water. At the rate at which the shore is now receding, it must be many years before the river can reach this dike, if it ever does; the dike, being built upon the soft soil underlaid by quicksand, must be destroyed, and another will have to be built below it. As the river now is, the rate of abrasion must be less than it formerly was, for the reason that the broad expanse of water between the bend and the mouth of the river acts as a cushion. However, it is not safe to rest upon this assumption, because another flood may produce changes above and below that may increase instead of diminishing the "wear."

The enormous destruction of land and property calls for some aid on the part of the Government. To protect the banks by revetment would be too costly and uncertain, the character of the bed at the foot of the banks not admitting of any load being placed upon it; piling, though it might be efficacious as long as it lasted, would most probably scour out, from the absence of any sufficiently tenacious soil to hold the piles.

My opinion, founded upon the results of the survey and such examinations as I made in December, is, that the most economical as well as thorough plan is the one suggested by you, viz, to control the action of the Missouri and Mississippi, as far as it can be done, by opening Mobile Chute and the chute to the west of Maple Island, and induce as much water as possible to flow through both.

From the best means at hand for calculating the expense, I would place it at $25,000. The loss to property-owners from the abrasion alone cannot be less than $100,000, counting improvements that have been made upon the land before it was destroyed, loss of crops, &c.

Should the channel straighten eventually, and pass west of Maple Island and through Mobile Chute, the necessity for throwing a dam across Alton Slough, already recommended, will be apparent, to prevent this slough from becoming the main channel in front of Alton.

Several bars of considerable magnitude exist at the mouth of the Missouri, and one at the entrance to Mobile Chute. I do not consider it necessary to do anything toward their removal.

The inhabitants could do much individually toward protecting and increasing their land, after the improvements recommended shall have been made, if they would plant willows on the bars in front of their farms, throwing in brush, stone, and refuse matter; the sediment deposited behind would not only make new land, but would serve to protect the land from medium stage of water, if not from floods. The land, having a respite from abrasion, would probably in a few years form a staple slope.

Long Lake is a long, narrow body of stagnant water, from 100 to 300 feet in width, following a very circuitous route south and southeast, through the American Bottoms, and originally ended in Cahokia Creek, which is a narrow, crooked, sluggish stream. Both of them are sometimes nearly dry. A dike has been built across the southern end of the lake, to prevent high water from the creek entering it, so that no water from any stream has entered the lake for more than ten years. This dike, together with the dike erected by the Levee Company, form a basin to receive the surface-water of that portion of the American Bottoms thus inclosed. (The map will give a better idea of it than any description.)

Following the meanderings of the lake and the creek to its mouth, opposite the lower portion of the city of St. Louis, it will be seen that the distance passed over is from two to three times the distance between the same points, following the channel of the river.

ST. LOUIS HARBOR.

The city front of St. Louis has a development of nearly 13 miles from the upper limits to the Des Peres, the southern or lower limits, and is mainly convex towards the river. The extent of the harbor has been considerably increased during the last two years by the addition of Carondelet to the city territory. Great changes have taken place in the shore line of the city, as well as in the condition of the harbor, during the last fifty years, and efforts have been made, both by the Government and by the citizens of St. Louis, to remove the original and successive evils.

The following description of the early obstructions to navigation and the dangers threatening the commerce of the city, as well as the efforts made for their removal, is taken from the complete and exhaustive report upon the harbor, made in 1868 and 1869, by Major Wm. E. Merrill, of the United States Corps of Engineers and brevet colonel United States Army, and which, although made to the common council of the city, should be among the professional papers of the corps. To discuss the subject in detail, based upon the examinations that I was enabled to make, would be little more than a mere repetition of his report. He says:

"The first effort at improvement was made in 1837, when Lieutenants Lee and Meigs, of the Engineers, were sent out by the General Government to devise and construct such works as might be necessary. At that time the river opposite the city was divided into two channels by Bloody Island, with the greater depth of water on the city side, though, during extreme low water, steamboats coming from the south had to pass up the eastern channel, and, turning the head of the island, drop down to the city landing. This was caused by a long flat bar extending from Bloody Island to Duncan's Island, (now incorporated into the city,) and though there was ample water above this bar, steamboats could not cross it during low stages of the river. For some time before the date of Lee's report, Duncan's Island had been growing rapidly, as well as the shoal connecting it with Bloody Island. Besides this, the course of the river above Bloody Island was tending more and more to the eastward, and the channel east of Bloody Island was yearly enlarging and diminishing the margin between itself and Cahokia Creek. The continuance of the forces in operation bid fair soon to give a channel for the river east of Bloody Island, and to take it entirely away from St. Louis. To prevent this, Lee recommended the closing of the eastern channel by a dam from the head of Bloody Island to the Illinois shore, and the construction of a longitudinal deflecting dike at the foot of Bloody Island, to wash away the shoal connecting it with Duncan's Island, as well as the greater portion of the island itself. The dam recommended was to be five feet above low water and 1,782 feet long. The longitudinal dike was to be 3,000 feet long, and also 5 feet above low water. In lieu of the dam, he thought a dike extending down stream from Old Venice, about 1,600 feet above the mouth of Kerr's Island Slough, and about three-fourths of a mile in length, (covering half of the distance between Venice and the head of Bloody Island,) would answer the same purposes. At the time Lee's map was made the width of the water-way, at a stage 12 feet above low water, was 1,835 feet at the narrows, or opposite Bissell's Point, and 1,238 feet in the channel east of Bloody Island, and 1,524 feet in the western channel, measured at the narrowest places. Now, at the narrows, we have a waterway of 2,560 feet.

"The dike from the foot of Bloody Island was begun in June, 1838, and finished as far down as opposite Market street by October of the same year, at which date Captain Lee made his second report. In this he abandons his first project of damming the eastern channel, and instead recommends the construction of the longitudinal dike from Venice. Of this last dike 1,300 feet was constructed in 1838, 1,850 feet in 1839, and 950 feet in 1840, being 4,100 feet in all, or 140 feet more than its originally designed length of three-fourths of a mile. The dike from the foot of Bloody Island seems never to have been constructed further down than opposite Market street. This dike was built by the United States out of the appropriation of $50,000 for the harbor of St. Louis, and cost $45,000. The other dike was built entirely by the city, with the slight assistance of the unexpended $5,000 appropriated by the General Government.

"The lower portion of the Bloody Island Dike has been kept up by constant repairs, and can yet be seen at low water at and below the site of the East St. Louis elevator, but of the upper dike there is now no vestige, excepting a slight ripple on the surface at very low stages. The upper dike was probably useful in preventing the threatened increase of the arm of the river east of Bloody Island, but its success was hardly proportionate to its cost. The lower dike was more useful, and a portion of it having been kept up, is of service to this day. Its immediate effect was to wash out a portion of Duncan's Island, and to deepen the water on the shoal between Duncan's and Bloody Islands. Both dikes were rather useful as preservatives against existing unfavorable conditions getting worse, than as cures for those conditions.

"In the spring of 1840, the city engineer, Mr. Kayser, reported that the current deflected from the upper dike, and rebounding from the vicinity of the water-works, was threatening the destruction of the lower dike by cutting it off from Bloody Island. He recommended the construction of two small spur-dikes at the head of the dike and a little below, to deflect the current.

"Authority to build these dikes was granted, and four were built instead of two, and the main dike was repaired. During the spring of 1841, repairs were made on both upper and lower dikes, the latter causing much trouble and anxiety. In June of this year, two breaches made their appearance in the lower dike, and it was repaired during the next season by connecting it by a cross-dike with the bar extending from the foot of Bloody Island. In November, 1842, there had been constructed seven spur-dikes for the protection of the western shore of Bloody Island. In August, 1843, City Engineer Reily reported that seven-elevenths of the river was flowing west of Bloody Island, and four-elevenths east, though the eastern channel had the greater velocity. Bad breaches in most of the dikes required repairs, and there were currents behind both of the main longitudinal dikes. Until 1850, the energies of the city were directed to keeping up the two main dikes already built, and the cross and spur dikes connected with them, the commencement of a dike northwardly from the head of Bloody Island, and the revetment of the island. During that time Duncan's Island was gradually lessening, and dikes were run out toward it from the streets opposite. A dike was also built in Cahokia Bend. In 1850, a low-water stone dam was built across the channel east of Bloody Island, which, however, was afterward carried away.

"In 1852 the present high-water dam connecting Bloody Island with the Illinois shore was built and made a highway. It finally closed the eastern channel. The stone dam below, first built, had so far closed this channel that no water ran through it until the river was 13 feet above low water.

"From this time up to the construction of the dike at the Grand Chain, no very considerable harbor works were undertaken. "What was left of Duncan's Island was connected with the city by dikes built across the slough, and the new wharf line was established along the eastern side of the island. The dike across the channel east of Bloody Island was raised and improved, occasional repairs were made to other dikes, and a few short dikes for the protection of Kerr's Island were built. These, however, lasted but a short time, the water speedily getting behind them, and cutting them off from the shore. The dike in Cahokia Bend was also extended. The history of the Grand Chain Dike has been given separately, and need not be repeated.

"The dike constructed by Mr. Bischoff, opposite Bissell's Point, was finished in the fall of 1868. During the latter part of the winter it was repaired, as also a small dike above the Ferry Landing and the Long Dike."

The actual expenditures on the harbor of St. Louis have been about $900,000, of which, as nearly as I can ascertain, the General Government has furnished $50,000, leaving the sum of $850,000 expended by the city government for its improvement.

Of the longitudinal dike connecting the head of Bloody Island with Venice, there was nothing discernible at the time of my examinations.

The state of the harbor, as given in Merrill's report, coincides very nearly with the state in which my survey found it, differing only where a difference might be looked for, viz, in the shore-lines, where abrasion is likely to occur, and in the position and dimensions of shoals. The bridge piers and abutments have been put in since the date of his report, and the harbor of Carondelet added to the harbor of St. Louis. Quoting from his report:

"The present condition of the harbor of St. Louis is as follows: The wharf-line of the city, as at present established, is seven miles and 145 feet in extent, commencing at the northern city limits at Bissell's Point, and extending to the southern city limits, three-quarters of a mile below the arsenal. With the exception of a section two squares in length, at North Market street, for the Madison County Ferry, no portion of the wharf from Bissell's Point to Biddle street has been built, the only work completed being the defining of the foot of the wharf by a low-water longitudinal dike, and the erection of occasional perpendicular dikes from the old bank to this dike, in order to check the current in high water, and raise the surface of the low lands by deposits of sediment. From Biddle street to Lombard street the wharf is finished; thence to the southern city limits nothing has been done except the construction of the dikes at Miller, Lesperance, Barton, and Anna streets, which terminate at the proposed front line of the wharf. The wharf-line, as now defined by ordinance, leaves the existing bank at Anna street, extending gradually into the river, until at its termination it is out in the river a distance of 700 feet. The regimen of the river at the lower part of the city having greatly changed since the establishment of this wharf-line, it is quite probable that subsequent legislation will change the lines of the lower part of the wharf southern.

"The current line of maximum velocity, after turning abruptly around the Grand Chain Dike, hugs the shore of the Sawyer Bend, to its southern extremity at Bissell's Point, whence it passes, in almost a straight line, to the Venice landing of the Madison County Ferry Company. Its eastward tendency is gradually overcome in the bend at and below Venice, until it turns westwardly, striking the bluffs of the city near the elevator. From the elevator to opposite the coal company's dike, the river is bounded on both sides by revetted banks, and may be said to be canalized. The rebound of the current, after impact at the elevator, causes a second rebound on the eastern shore, near the coal dike, whence it returns to the Missouri shore, hugging it closely to the southern city limits, passing to the westward of Arsenal Island. Throughout the middle and southern portions of the harbor there is good water at all stages along the city wharf, but from Bissell's Point to Mullanphy street there is no place where a vessel can land during extreme low water, and but few places where one can land during moderate water. The commercial interests of the city, especially the lumber business, which requires plenty of space, demand that some means be employed to put the wharf northern in as good a condition as the wharf southern. The city has spent so much already in improving this wharf, and in acquiring the land for it, that it is important to secure a revenue from it at the earliest possible moment. The width of the bar, opposite the wharf northern, measured at Destrehan street, during extreme low water, is 1,500 feet, and this is about its maximum width. In other words, at this point the low-water channel of the river is 1,500 feet east of the wharf-line, with this wide, dry bar between them. The shape of the bar is the segment of an ellipse, the extremities of the base being at Ferry and Mullanphy streets. It is not, however, permanent in outline, though quite so in general position and magnitude.

"Between the upper end of this bar and the longitudinal dike there is a narrow swash-channel, which, below Destrehan street, turns eastward, cutting the bar into two parts, the northern being rather the longer."

This was the condition of the harbor in 1868 and 1869.

The earlier efforts, it would seem, were directed toward deepening the channel between Bloody Island and along the city front, from a point a little above the head of the island to the site of the United States arsenal, and this has been pretty thoroughly accomplished, there having been, for a number of years, good water along the wharf-line in front of the central portion of the city. The construction of the dikes around Bloody Island prevented the encroachments of the river upon the margin of Cahokia Creek, the dike along the lower end of the island, in connection with the spur-dikes, besides deflecting the current toward Duncan's Island, securing Bloody Island itself against abrasion. A small portion of this dike was visible at the time of our examinations. Bloody Island, which, at the time of the surveys made by Captains Lee and Cram in 1837 and 1843, and for some time after, was entirely surrounded by water with a steamboat channel on each side of it, has entirely lost its distinctive character. It is now connected with the main-land by a series of dikes and causeways, and the original channel entirely filled up, with the exception of an occasional pool of water. It is leveed and revetted throughout nearly its entire original length, and it now constitutes what is called East St. Louis. The railroads from the northeast, east, and southeast all center here, and the channel between it and the city of St. Louis is soon to be spanned by a bridge, the piers of which are nearly completed, one of the greatest engineering triumphs of modern days. The result of the closing of the slough behind Bloody Island has been to throw the entire body of water passing through that slough into the present channel west of the island, and to the scouring force resulting from this addition of water is due the depth of water along this portion of the harbor.

Deep water and good navigation originally obtained along the wharf-line in the northern part of the harbor until about 1851. Previous to that year a large portion of the river flowed to the east of Cabaret Island through the slough, now almost entirely closed up with sand. The flood of that year produced changes that materially altered the circumstances of flow, and the greater portion of the water that originally flowed through Cabaret Slough was deflected to the west of the island, passing through Pocket Chute, and also along Sawyer's Bend.

The northern wharf-line of the city has been gradually extended out toward the river, at what rate previous to 1851, I am not positive. Very soon after the flood spoken of, a large bar began to form along the northern wharf-line, probably due to the changes produced by the flood, as well as, to a certain extent, the changes in the line of wharf. As the formation of the bar commenced soon after the deflection of the water from Cabaret Slough to the west of the island, it would seem reasonable to suppose that any method which would throw the water back into the slough and produce the same state of things that existed before the flood, would have the desired effect upon the harbor. After the presentation of several plans, it was finally decided, in 1867, or thereabouts, to construct a dike upon the chain of rocks, to deflect the water into the slough, and it was constructed the following year, at an expense to the city of $92,000; the perpendicular portion was 1,400 feet in length, and the longitudinal portion 2,000 feet. As previously stated, it has not had the effect intended. The slough is rapidly filling up instead of scouring out. The dike is causing increased abrasion of the bend below it. The latter, Sawyer's Bend, is wearing rapidly, and unless some means are taken to prevent further encroachments, it is my opinion that considerable damage will eventually accrue to the site of the new water-works. Revetment of this bank for the entire distance would, no doubt, stop the encroachments, so long as the revetment remained, but this is too costly an experiment to be recommended until it is decided that no other means can be adopted. Borings along portions of this front show (as I am informed) that nothing but sediment and sand constitute the bed of the river for 60 to 70 feet down to the underlying rock. The banks are steep, and average 20 to 30 feet above the river surface at low water. Without going into an estimate of the cost of providing a revetment of any nature along this bend, it will be apparent that it would be very expensive, whether viewed in the light of an experiment, or as an undertaking with a surety of success.

Gingrass Creek has been reached; this is a ravine nearly dry at times, emptying into the harbor near Salisbury street. Tracing it up, it runs parallel to the river and at an average distance of 1,400 feet from it, until it reaches a point opposite the foot of Cabaret Island Slough, when it inclines toward the river, striking it at a point about half a mile above the foot of Cabaret Island; thence turning from the river, it is lost in the bluffs. Its rise, as far as traced, appeared to be nearly opposite the middle of Cabaret Island. The new water-works are built on the strip of land bordered by this creek and the river. In addition to the Grand Chain Dike, the city has erected a number of others at various points in the harbor. There are four of these visible in the upper harbor, on the Illinois side of the river. The first dike, called Bischoff's Dike, is in the best condition; the water rushes around the outer end with great force, and strikes the shore a short distance below; it is inclined a little up stream and extends nearly half across the river from the Illinois shore. A little below this dike is a much smaller one; a short distance below the Madison County Ferry Landing is another small dike; about half-way from Bischoff's Dike to the head of Bloody Island is what is called the Long Dike; near the shore there is a wide breach, through which the water rushes with great force, and has worn for itself a deep channel close to the shore, and between the shore and the large sand-bar below the dike, the water flowing through this chute and around the head of Bloody Island. The shore in the bend below the dike is rapidly wearing, the abrasion having extended to the distance of about 150 feet since Merrill's survey. The beach in the Long Dike should be thoroughly repaired. At the time I last examined it, the ferry company were making some repairs upon it, to preserve their land.

These dikes, commencing with the upper or Bischoff's, I have numbered 1, 2, 3, and 4. Between dikes 2 and 3 is the Madison County Ferry Landing, which serves the purpose of a short dike.

Below Bloody Island, and opposite the foot of Chouteau avenue, is what is called the Coal Dike, about 1,900 feet in length, and perpendicular to the direction of the present channel of the river. This is the only case, apparently, where a dike in the harbor has thoroughly accomplished all that was expected of it. It has had the effect of throwing the current against the St. Louis shore, clearing out the bar formed there many years ago, and filling up the old steamboat channel along the Illinois shore to a point above low-water mark, and from 1,500 to 3,500 feet in width, extending from the lower end of Bloody Island to Arsenal Island. The value of the land formed by constructing this dike will more than repay the cost of its construction.

The next dike that is still visible is at the head of Arsenal Island. This dike was built by the city of St. Louis for the purpose of deflecting the current down the channel between Arsenal Island and the city of St. Louis. The main channel of the river has several times changed during the last fifty years, from west to east, and from east to west of Arsenal Island; it is now on the west side of the island, and probably will remain so, as the Coal Dike opposite Chouteau avenue has the effect of constantly making land below it, and deflecting the current to the opposite shore. The dike across the slough, at the head of Arsenal Island, if it ever closed up that slough, has now a large break in it, and a considerable body of water rushes through between it and the head of the island, wearing away the head of the latter. This slough should be closed up, and the island revetted at the head, and for some distance down the west side.

The survey showed that good water exists all along the city front, from Mullanphy street down to the arsenal, and all along Bloody Island front, to a point about midway between the point of the Coal Dike and the East St. Louis elevator. Along this portion is a narrow bar, but as there is little necessity for boats landing along this portion, the bar cannot be called an obstruction to navigation, neither do I apprehend that it will extend out far enough into the channel to occasion any trouble.

The large bar along the wharf (northern) described in Merrill's report has decreased in size, due, in my opinion, to the effect of the dikes, particularly the upper one. The maximum width of the bar at lowest water is about 1,000 feet. At medium stages the bar would average about 150 to 200 feet in width, although there are points where a landing can be effected. Still, although there has been an evident scour and reduction of the size of the bar within the last three years, the evil still exists in full force, as a narrow bar as much precludes the landing of boats as a broad one.

Opposite the head of Bloody Island, but nearer to the Missouri shore, in front of the city, is a large irregular bar, extending some distance above and below the head of the island, with a deep channel all around it. The dikes, although they seem to have effected a removal of some portion of the obstructions along the northern wharf, have caused considerable deposits below them. These bars, as soon as they come within the scouring influence of the current, must be carried below the foot of Bloody Island, and probably below Arsenal Island. A further extension of all the dikes would seem to be desirable, the upper dike (known as Bischoff's) needing the least.

For a distance of more than a mile above the upper dike, (No. 1,) the channel is of uniform width, and for this distance, and below the dike along the wharf-line, the bar has its minimum width until a point above the old water-works is reached.

The Illinois shore, in the bend opposite the city, requires protection, either by raising the dikes, or by revetment.

The deepening of Pocket Chute, as stated in that portion of my report pertaining to the general survey, would probably relieve the bank in Sawyer's Bend from some portion of the abrasion it now suffers; but it would not, in my opinion, be sufficient in itself to scour out any large portion of the bar in the upper portion of the harbor.

Undoubtedly, if the river could be made to take the same course as it had before the Cabaret Slough was closed up, the upper portion of the harbor would attain very nearly the same condition that it had before the flood of 1851. Should this ever obtain, the Cabaret Slough would require revetment of some portion of its banks.

The bar at the lower end of Carondelet occasions some anxiety to those interested in that portion of the harbor, and it is thought by them that the evil bids fair to be of sufficient magnitude to call for the erection of dikes on the opposite side of the river, to remove the bar along this portion of the front as well as along that portion of the Government reservation upon which are situated the powder-magazines. I have been unable to discover any great difficulty to boats landing along the reservation front, and the commanding officer at the barracks informed me that there was no difficulty in making landings at that point. Dikes opposite the lower portion of the city would, undoubtedly, improve the portion of the Carondelet Harbor where the bar exists, but the extent of my examinations does not admit of any conclusive statement as to their absolute necessity or cost. All the experiments made in the improvement of the harbor have shown the difficulty, where any scouring occurs, of providing any structure for the protection of the banks, or to serve to deflect the water, unless the structure rests directly upon the bed-rock. As the rock is a great distance below the bed of the river, the amount of material required for the smallest structure would be very great, and would be only conjectural, unless direct examinations were made to ascertain the depth as well as stability of the deposit. In the absence of any such examinations of my own, I have taken the following extract from a report made by Messrs. Homer and Moulton in a communication to W. J. McAlpine, president of the board of engineers, convened at St. Louis, in August, 1867, to consider the project of a bridge across the river:

"Four borings were made in the river in continuation of the north line of Green street; the first at a distance of 265 feet east of the west line of the wharf, where the rock was found coincident with the bed of the river at minus 56.70, or 22.89 feet below low water;

the second at a point 500 feet east of the last point, where the rock was found at a depth of minus 97.46, or 63.65 feet below low water, and the water had a depth of 13.7 feet, leaving 49.95 as the thickness of the river deposit above the rock; the third was at a point 500 feet still further east of the last point, where the rock was found at a depth of minus 123.33, or 89.52 feet below low water; here the water was 10.19 feet deep, leaving 79.33 feet as the thickness of the river deposit above the rock; the fourth was at a point 500 feet still further east, where the boring was carried to a depth of minus 101.42, or 67.61 feet below low water, and then abandoned on account of the breaking up of the ice. At this point the water was 16.19 feet deep, and the river deposit was penetrated through a thickness of 51.42 feet. These borings were made early in the winter of 1866."

Chief Engineer James B. Eads, in his last report upon the St. Louis bridge, of October 1, 1870, says, in regard to the building of the east pier:

"During low water, the normal deposit of sand over the bed-rock at this pier is about 80 feet. A rise in the river causes it to scour down, while a subsidence of the flood permits the moving sands from above to deposit rapidly and again raise the sand-bed. At the time of placing the caisson in position, the water in the river was 35 feet deep, and 68 feet of sand was then overlying the rock."

It is beyond doubt that the rock underlies the movable mass of sand to a great depth all over the harbor. I am informed that attempts have been made to protect the banks in front of the new water-works at Bissell's Point, by constructing a rip-rap wall, and that the stone disappeared as rapidly as thrown in. The fate of the numerous dikes constructed all around the harbor, where they did not extend to the bed-rock, is another proof of the point in question and the force of the scour. Single dikes, and even the most extensive system of dikes, frequently fail to answer the expectations of those who build them. Perpendicular dikes, although less subject to scour on the up-stream side than oblique dikes, nevertheless suffer heavy scour around the heads and along their lower faces, from the effects of the currents running around and along them. When the river flows over them, the lower edges are frequently undermined by the action of the water as it falls over the crest, causing the dike to settle on that side. The current, backed up by the dike, follows a line drawn from the highest point to which it is backed, to some point on the prolongation of the axis of the dike, the distance of this point from the dike depending upon the circumstances of flow. From this point it gradually "*draws*" around the point of the dike, forming an eddy and consequent bar below it, frequently scouring out the bank below the dike and between the bar and the line of banks. This scour may be prevented by the construction of smaller dikes below, or by revetment of the banks. In no case should there be long reaches of shore between dikes unprotected either by revetment or spur-dikes.

The preferable way, in my opinion, unless the expense totally forbids it, to contract a water-way, is to construct longitudinal dikes, so arranged as to give to the river at each point (measured along its axis) an area of cross-section just sufficient to admit the passage of a volume of water depending upon a velocity consistent with the regimen and navigation of the river at that point. Too high and too low dikes should be equally avoided. Whenever possible, the dike or levee should be so sloped as to graduate this discharge of water at all stages. During its progress careful observation should be made upon the river, and the engineer should be at liberty to modify the plans as he proceeds with the work. When once commenced, the work should not be stopped for want of funds, but pushed vigorously to its completion. Half-matured plans and half-finished hydraulic works produce more mischief, generally, than the evils they are intended to remedy.

My examinations of the river, and particularly of the harbor of St. Louis, although as extensive as the funds at command and the time would admit of, are necessarily incomplete. I have therefore confined myself mainly to a statement of the condition of the harbor as my survey found it, leaving out any recommendation for a general plan of improvement. I am constrained to do this, for there are so many questions involved requiring the possession of data which I could not obtain, and which are necessary to the solution of even the most insignificant hydraulic problems, and without which it would be impossible to arrive at any satisfactory conclusions, either as to plan or cost.

In the presentation of a plan of improvement, not only should it be comprehensive, but it should be, if possible, the minimum one in regard to cost. To get at this requires a complete and systematic survey of the harbor throughout, as well as the river above it to the Missouri, and up the latter for several miles and below the city for at least ten miles, and thorough hydrographic and hydrometric examinations for at least one year, from flood to flood, and throughout the varying stages. Borings, also, should be made at the points designed for revetments or dikes, and the abrasion of the shore steadily watched. The whole valley, from bluff to bluff, should be, in fact, surveyed.

There have been frequent examinations of particular localities within the last twenty-five years, but nothing continuous. Material changes have taken place, both natural and artificial, since the extensive survey of 1843, and the extent of the harbor has been increased since the one of 1868–'69. Neither of these latter extended below the city for any distance.

A thorough survey of the nature described, and which would be economical in the end, would cost about $25,000.

Statistics of the city.

Population, according to last census, 310,864; amount of coal received in 1870, 23,918,225 bushels; number of buildings erected in 1870, 1,134, costing $7,307,525.

Statistics of the port.

Number of steamers and barges employed in the trade: Steamers 209, barges 229, with a carrying capacity of 236,960 tons, and valued at $6,844,200.

Number of arrivals and departures of vessels in 1870: Arrivals, 2,796 steamers, 1,195 barges. Departures, 2,782 steamers; number of barges not given.

St. Louis is situated in first collection district of Missouri. Amount of internal revenue collected for the year ending June 30, 1870, $5,081,287 05.

Revenue from customs.

Imports in coin	$1,864,449 06
Tonnage dues	24,243 70
Inspection fees	12,424 78
Hospital dues	6,939 43
	1,908,056 97

Tonnage.

	No.	Tons.
Steam-vessels enrolled	141	62,891.47
Barges enrolled	61	24,215.35
Total	202	87,106.82

Within the city limits are the custom-house and United States arsenal. The nearest Government building outside the city limits is Jefferson Barracks.

With this report I inclose two tracings, one general map of the survey on a scale of 3,600 feet to the inch, and one special map of St. Louis Harbor from the upper city limits to the lower old city limits, on a scale of 600 feet to the inch.

Mr. McGregory, my assistant in the survey, was, at one time, city engineer of Alton, and since has been engaged on land surveys in Madison County, Illinois. To his researches I am indebted for the information obtained regarding the old land surveys, as well as for other points of the examination.

Recapitulation of estimates.

For Alton Harbor	$14,662 50
For mouth of Missouri	25,000 00
For general survey	25,000 00
	64,662 50

I am, colonel, very respectfully, your obedient servant,

CHAS. J. ALLEN,
Captain of Engineers.

Lieutenant Colonel WILLIAM F. RAYNOLDS,
United States Corps of Engineers, in charge of
Western River Improvements, St. Louis, Missouri.

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OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, December 28, 1870.

GENERAL: I have the honor to forward herewith the report of an examination of the Osage River. made under my direction by Mr. D.

Fitzgerald, in compliance with your instructions of the 23d of July and 23d of August last.

Mr. Fitzgerald proposes to improve this stream by dredging the shoals, and gives it as his opinion that by this method 3 feet of water can be maintained for nine months in the year.

It is to be regretted that the means were not furnished to obtain more accurate data upon which to base an estimate than was done in this case. Mr. Fitzgerald did all that could be expected under the circumstances, and his opinion is entitled to all the weight that is due to one who has *seen* that of which he speaks. Still the "examination" was nothing more than what could be made while passing rapidly down the stream, and his opinion cannot be taken as an accurate estimate. He has, however, left so large a margin as to leave little doubt that the navigation of this stream can be so much improved as to afford priceless benefit upon the country through which it flows; for if, instead of three feet, as proposed by Mr. Fitzgerald, 2½ or even 2 feet can be maintained during nine months of the year, it will afford the means of shipping a large amount of produce which at present is unable to reach a market.

The table given in the report of "the counties touching directly on the river, not including those on its tributaries," shows the area of those counties to be 5,290 square miles—the population, in 1860, to have been 61,627, and the taxable wealth to have been $22,947,892. The population at present is probably over 100,000, and as the "taxable wealth" is always much less than the actual value, the present real value of the property in the counties named cannot be estimated at less than $100,000,000. This gives an idea of the importance of the improvement proposed.

The estimates given are on the supposition that no rock in place will be met with in the excavation. All the information that I have obtained sustains Mr. Fitzgerald's opinion that this will not be the case.

Mr. Fitzgerald does not estimate for a small steamer for attending upon and moving the dredge, or for contingencies of any kind; to meet these an addition of not less than 10 per cent. should be made to the amount he thinks will be necessary, making the total amount required for the proposed improvement of the Osage River from its mouth to Roscoe, $200,000, of which $50,000 would be required the first year. This amount, expended judiciously between the mouth and Tuscumbia, would afford material relief and test the method of the improvement proposed.

Very respectfully,

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

(A tracing of the map accompanying the report will be forwarded in a separate package.)

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, November 30, 1870.

COLONEL: On the 1st of October I received instructions from you to make a preliminary examination of the Osage River with reference to the improvement of navigation.

As neither the means nor the time were sufficient to make an accurate survey, I determined, with your sanction, to proceed to the head of navigation and float down the river, taking as full notes of the physical features of the valley and the difficulties to be overcome as was possible under the circumstances. Accordingly, I left St. Louis on the same day, and have since been over the entire length of the river. I now have the honor to present my report.

The Osage River takes it rise in the plains between the Arkansas and Kansas rivers, in the easterly part of Kansas, and flows east-northeast for a general direction, crossing nearly the whole breadth of the State of Missouri, and emptying into the Missouri River eight miles below Jefferson City and about four hundred and fifty from its source. It is the most important tributary that the Missouri River receives in this State. The drainage area occupied by the Osage amounts to about thirteen thousand six hundred square miles, or nearly one thirty-sixth of the whole Missouri basin.

Near the Kansas border the Osage receives its water from two branches, the Marais de Cygnes and the Little Osage, of which the former is the larger, although at this point they are neither of them much more than good-sized creeks. Three miles above their junction and on the Marais de Cygnes there is a small town named Papinsville, which is located on the maps as the head of navigation. To this place we proceeded on the 3d by way of Sedalia. The town has about 500 inhabitants, and is twenty miles distant from the Kansas border and about thirty-five miles from Fort Scott. Boats very rarely run up as far as this point, and no dependence for freights is placed upon them.

For more than a year previous to my examination, there had been an unusually dry season and the river was very low.

At Papinsville there was a small running stream with about six inches of water in the rapids below the town. In times of great freshet, however, they have some 20 feet of water, and then if a boat is sufficiently venturesome to run the risk of being left by the sudden falling of the river, it can come up as far as the town. A bridge of 90 feet span crosses the river at this place.

On the 4th I procured a skiff and started from Papinsville on my way down the river. Three miles below town the Little Osage empties in, and for several miles there is a fine pool of clear water, with no perceptible current, averaging 150 feet in width, and 5 feet in depth. For the next sixty or seventy miles the river is one succession of pools and shoals, some of the latter a mile in length and most of them, in extreme low water, have but from 3 to 6 inches of water. In this distance there are two small towns, Belvoir and Taberville. Twelve miles below the former we found a bridge in course of construction on the Missouri, Kansas and Texas Railway. There is to be a draw in the bridge 60 feet span in the clear. The only other bridge across the river is at Osage City, at the mouth, on the Missouri Pacific Railroad. This bridge is 1,120 feet long, composed of seven spans of 160 feet each, with a draw-span of the same length with the others, leaving 65 feet in the clear on each side of the draw-pier.

On the 7th we reached the mouth of the Sac River, which flows in from the south. It is nearly as large a river as the Osage itself. Some nine miles above its mouth is Roscoe, a flourishing little town of 500 people; and below the Sac, three miles, is Osceola, the county seat of St. Clair County, with some 600 inhabitants. As this point of the river seems to be the practical head of navigation, and as no improvements will probably ever extend above here, I have made my map only from the mouth of the Sac to the Missouri River. Between Roscoe and Osceola there cannot be more than 6 feet fall in the river.

After receiving the waters of the Sac, the Osage is about 350 feet wide between banks. On one side is a perpendicular bluff, on the other a timbered bottom with a soft bank of sandy loam some 15 feet in height.

From Osceola to the mouth I made a more particular examination, taking sketches of nearly all the shoals, noting the course of every bend and stretch in the river, and checking the distances as given me by the pilot, by the intersection of the section lines. By this means I have been able to make an approximate map, sufficiently accurate to show the course of the river and the location of the shoals.

Before we reached Linn Creek we were overtaken by a sudden rise of 8 feet, and for particulars of the shoals below that point I was obliged to rely upon the description of the pilot.

We reached the mouth of the river during the first of November, having been engaged in the examination a little more than a month.

GENERAL DESCRIPTION.

The valley.—The Osage Valley may be described as a very fertile country, capable of high cultivation, but now almost wholly undeveloped. The farmers, having no certain outlet for their crops, have little stimulus to raise more than is needed for their own use.

Counties.—The counties touching directly upon the river from Roscoe to the Missouri, not including those lying on its tributaries, are St. Clair, Henry, Benton, Morgan, Camden, Miller, Cole, and Osage. The taxable wealth of these counties has been estimated at $22,947,892. The following table will show their area, resources, &c.

Counties.	Area.	Population.	Taxable wealth.	Minerals.
		1860.	1860.	
Benton	770	9,072	$2,969,869	Copper, lead.
Camden	600	3,287	890,462	Lead, iron, saltpeter.
Cole	410	9,697	4,200,050	Lead, coal.
Henry	750	9,866	6,670,565	Iron, coal.
Miller	570	6,812	1,407,870	Lead, iron, coal.
Morgan	690	8,202	2,348,510	Lead, coal.
Osage	850	7,879	1,812,953	Iron, lead.
St. Clair	650	6,812	2,647,613	Iron, coal.
Total	5,290	61,627	22,947,892	

The soil.—The soil of the valley is rich and may be depended upon to produce large crops of corn, wheat, oats, tobacco, hay, &c. The banks of the river are heavily timbered; a number of saw-mills have been erected, and more are building. I noticed a great quantity of very fine white oak, black walnut, and cedar, enough to supply any market.

Sulphur springs.—Between Osceola and Warsaw there are a number of very fine mineral springs; some of them have attained a wide reputation. As many as a hundred persons have been seen camping in their neighborhood at one time, for the benefit of the water. I was informed that in the Sulphur Creek bend there was one spot where there were at least one hundred different kinds of water, all of them highly charged with medicinal properties.

Minerals.—The principal minerals are lead and iron. The lead deposits are very rich, and, although mined in a crude way by the farmers, already form quite an item of freight. If there were any certain means of transporting the ore to market, there is little doubt that it would form a leading source of wealth to the valley and State.

Towns.—The principal points of business on the Osage below Roscoe are, Osceola, Warsaw, Linn Creek, Tuscumbia, Castle Rock, and Osage City. The amount of all kinds of business done in the most important of these towns amounts to from $300,000 to $500,000 in each town, in the course of the year.

The Osage River.—The Osage River, for nearly its whole course, passes from one rocky bluff to another, leaving a bottom on one side and a high bluff on the other. The principal geological formations are solid strata of carboniferous and silurian limestone and sandstone. The second and third magnesium limestones are very plentiful, as also the second and third sandstones.

After leaving Osceola, the river runs for some distance through St. Clair County, touches a corner of Henry County, and runs through the whole breadth of Benton County. Warsaw, the county seat, is situated on the river.

After touching, next, a corner of Morgan County, the Osage passes southeast into Camden County to its county seat, Linn Creek. From here, the river passes again through a portion of Morgan and then through Miller County, whose county seat, Tuscumbia, is on the banks. The river then becomes the boundary line between Cole and Osage Counties, and flowing past Osage City, a small town at the mouth, loses itself in the waters of the Missouri.

The following will show the distances between different points of the river and St. Louis:

Table of distances. (*Estimated.*)

Distance from St. Louis to—	Intermediate distances.	Distance from St. Louis.
	Miles.	*Miles.*
Osage City	16	145
Castle Rock	16	161
St. Elizabeth	27	188
Tuscumbia	16.5	204.5
Linn Creek	48	252.5
Warsaw	59.5	312
Osceola	54	366
Roscoe	12	378

Between Osceola and Warsaw, a distance of fifty-four miles, there are thirty-eight shoals. These I have divided into four classes, according to the amount of fall and the difficulties which boats have in making a passage over them at low water. Those in class 1 have a fall of from 2 to 3 feet; class 2, about 1.5 feet, and so on, those in class 4 having a fall of only a few inches. This is an approximate classification, as I was able to take instrumental observations at but few of them.

Class 1	4 shoals.
Class 2	7 shoals.
Class 3	14 shoals.
Class 4	13 shoals.

Between Warsaw and Linn Creek, a distance of 59.5 miles, there are thirty-eight shoals.

Class 1	13 shoals.
Class 2	9 shoals.
Class 3	13 shoals.
Class 4	3 shoals.

Between Linn Creek and Tuscumbia, forty-eight miles, there are twenty-six shoals.

Class 1	6 shoals.
Class 2	6 shoals.
Class 3	12 shoals.
Class 4	2 shoals.

Between Tuscumbia and the mouth, 59.5 miles, there are twenty-four shoals.

Class 1	6 shoals.
Class 2	10 shoals.
Class 3	6 shoals.
Class 4	2 shoals.

At extreme low water nearly all the fall of the river is concentrated at the shoals, while between them the water stands at nearly a dead level. They differ very little in their general characteristics. Their fall is on an average about 1.25 feet, and their length from 1 to 800 feet.

From Osceola to Osage, a distance of two hundred and twenty-one miles, there are twenty-one hundred and six shoals, making an average of one shoal to every 1.75 miles. The materials of which they are composed are gravel, loose rock, and sand.

The water on the shoals between Osceola and Tuscumbia was generally from 10 to 14 inches in depth, while on the shoals in the lower portion of the river the water was from 14 to 17 inches deep.

The pools have always enough water. They are the basins of the river. At the lowest stages the water runs from 6 to 20 feet deep, and they occur in some cases in stretches of several miles without any shoal.

At Osceola the width of the river is 400 feet; at Osage City 1,000 feet, varying between the two at intermediate points.

I refrain from a detailed description of the topography or course of the river, as the map will show both, together with the location of the shoals.

The river is remarkably free from snags. It was only occasionally that we came across one which was in the way of navigation.

Efforts have been made in previous years to improve the Osage River. I counted more than a hundred brush-wing dams; some still in good order, but most of them, more or less, sunken and injured by the ice. Owing to their location and the way in which they were built, they have done very little permanent good, while they are the frequent source of cross-currents.

There seems to be but two methods which present themselves for the improvement of the Osage in view of the above facts:

First. By locking and damming the river.

Second. By dredging the shoals.

I have made no estimate for the former, deeming that the advantages would not warrant the enormous expenditure which would be required.

By dredging, I have estimated that the removal of 210,000 cubic yards of material, at 75 cents per yard, $157,500, will improve the river from the Missouri River to Roscoe so as to give nine months' navigation on 3 feet of water.

As it will be necessary to build a dredge-boat for the work, the additional sum of $16,500 will be required, making in all $174,000, and including engineering, superintendence, laying out of work, &c., $180,000.

In the expenditure of this sum I would recommend that the portion of the river lying between Osage City and Tuscumbia be first improved by the removal of 38,000 cubic yards, at an expense of $28,500, and including the dredge-boat, $16,500, and $5,000 for engineering—$50,000. It will be necessary to have a competent engineer and assistant stationed on the work to take accurate notes of the cross-sections of water on the shoals as the dredging proceeds, and regulate the work as his observations may dictate.

Estimate for the improvement of the river from the mouth to Roscoe, a distance of two hundred and thirty-three miles.

210,000 cubic yards excavation, at 75 cents	$157,500
Appropriation for dredge-boat	16,500
Engineering, &c	6,000
Total	180,000

Estimate for the improvement of the lower portion of the river only, from Osage City to Tuscumbia, 59.5 miles.

38,000 cubic yards excavation, at 75 cents	$28,500
Appropriation for dredge-boat	16,500
Engineering, &c	5,000
Total	50,000

I have mentioned nothing of the Government lands in the Osage valley, which have been estimated by other parties at half a million acres. These lands would undoubtedly find a more ready market and an enhanced value if the improvements proposed are carried out on the part of the Government.

I subjoin a list of the shoals, showing their names and order of location from Osceola to the mouth of the river.

I have the honor to be, very respectfully, yours,

DESMOND FITZGERALD.

Lieutenant Colonel W. F. RAYNOLDS,
United States Corps of Engineers.

Table of shoals from Osceola to the mouth of the Osage River.

Number.	Name of shoal.	Class.	Number.	Name of shoal.	Class.
1	Osceola Shoal	2		WARSAW.	
2, 3	Crow Island Shoal	3			
4	Musgrove Shoal	2	39	Howser Shoal	3
5	Warblean Shoal	2	40	Hackberry Shoal	1
6	Peevely Shoal	4	41	Vaughn Shoal	3
7	Dodd Hinckle Shoal	4	42	Jeans Shoal	3
8	Bear Creek Shoal	3	43	George Williams's Shoal	3
9	Huntsville Shoal	1	44	Turkey Creek Shoal	1
10	Alford Shoal	3	45	Cole Camp Shoal	3
11	North Shoal	3	46	Morsey Shoal	2
12	Ben Brown Shoal	4	47	Brushy Shoal	3
13	Muddy Island Shoal	4	48	Denton Shoal	2
14	Miller Island Shoal	4	49	Knobby Shoal	3
15	Tally Shoal	3	50	Trenstan's Bar	4
16	Tom Wright Shoal	2	51, 52	Buffalo Shoal	1
17, 18	Upper and Lower Wagoner Shoals	1	53	Paint Rock Shoal	1
19	——— Shoal	4	54	Flipping Shoal	2
20	Hatcher Shoal	4	55	Little Buffalo Shoal	4
21	Waldo Island Shoal	3	56	Wigwam Shoal	1
22	Dawson Shoal	1	57	Couche Island Shoal	3
23	Otter Shoal	3	58	Billy Brown Shoal	4
24	Nichols Island Shoal	3	59	Rise Branch Shoal	1
25	Berry Mill Shoal	4	60	Rainey Creek Shoal	3
26, 27	Sulphur Spring Shoal	3	61	Seth Moore Shoal	3
28	Dean Island Shoal	2	62	Byers Shoal	2
29	——— Shoal	4	63	Proctor Shoal	2
30	Crane Island Shoal	3	64	McFarland Shoal	2
31	Teele Ford Shoal	2	65	Coffman Shoal	3
32	Holcomb Ford Shoal	3	66, 67	Wilson Shoal	1
33	Wickliffe Shoal	4	68	Henry Cable Shoal	1
34	Holloway Shoal	2	69	Sam Cable Shoal	3
35	Wright Island Shoal	4	70	Carroll Shoal	2
36	Davison Island Shoal	3	71	Bolinger Shoal	2
37	Dunwoody Shoal	4	72	Porter Island Shoal	1
38	Sailor Shoal	3	73	Foster Shoal	1

Table of shoals from, Osceola, &c.—Continued.

Number.	Name of shoal.	Class.	Number.	Name of shoal.	Class.
74	Cash Williams's Shoal	1	100	Linn Buckman Shoal	3
75	Melbourne Williams's Shoal	2	101	Bed Quilt Shoal	1
76	Dodson Bar	3	102	Tuscumbia Flats	3
	LINN CREEK.			TUSCUMBIA.	
			103	Birdsong Shoal	2
77	Linn Creek Shoal	1	104	Saline Creek Shoal	2
78	Towne Shoal	4	105	Music Island Shoal	3
79	Friar Ear Shoal	3	106	Berry Island Shoal	4
80	Foley Island Shoal	1	107	Packs Island Shoal	3
81	Big Kinsile Shoal	2	108	Devil's Elbow Shoal	4
82	Little Kinsile Shoal	3	109	Kirkman Shoal	2
83	Dr. Little Shoal	3	110	North St. Louis Shoal	2
84	Salt Island Shoal	2	111	Little Tavern Shoal	2
85	Anglaise Shoal	3	112	Clark Shoal	3
86	Raip Shoal	3	113	Moore Flats	3
87	Wash Lamb Shoal	2	114	Sugar Creek Shoal	3
88	Wide Ford Shoal	3	115	Shiler Shoal	2
89	Round Island Shoal	1	116	White Oak Shoal	2
90	Widow Stevens Shoal	4	117	Bob Ruly Shoal	1
91	Big Gravois Shoal	1	118	Waller Bottom Shoal	2
92	Steph. Howser Shoal	1	119	Dixon Shoal	1
93	Middle Howser Shoal	2	120	Round Bottom Shoal	1
94	Lower Howser Shoal	3	121	Bird Shoal	2
95	Easters Shoal	3	122	Locket Shoal	4
96	Little Gravois Shoal	2	123	General Bottom Shoal	1
97	Granny Shoal	2	124	Rice Shoal	1
98	Russell Island Shoal	3	125	Prince Island Shoal	3
99	Brockman Flats	3	126	Shipley Shoal	1

OSAGE CITY.

OFFICE WESTERN RIVER IMPROVEMENTS,
1122 *Pine Street, St. Louis, Missouri, October* 14, 1871.

GENERAL: I have the honor to submit my annual report of operations upon the "Improvement of the Osage River in Missouri."

A report forwarded to the Bureau on the 28th of December last contained estimates of the cost of the improvement of this stream from Roscoe to its mouth, a distance of two hundred and thirty-three miles, of $180,000, and also separate estimates of the cost of improving the lower section from Tuscumbia to the mouth, of $50,000; and the appropriation of the last-named sum was recommended.

The act of Congress approved March 3, 1871, made an appropriation for the "Improvement of Osage River, Missouri," of $25,000.

The estimate of $50,000 for the improvement to Tuscumbia contained the item of $16,500 for the construction of a dredge-boat for doing the work. As the cost of a dredge would be so large a proportion of the amount appropriated that, if one was procured, there would be no hope of rendering any material aid to navigation without another appropriation, I recommended an attempt should be made to open a channel by means of scrapers. This recommendation was approved by the Bureau.

A competent superintendent was employed in the month of July, and a careful examination of the lower portion of the stream commenced.

At first, the stage of water rendered the use of scrapers impracticable; authority was then asked, and given, to hire a dredge. But after careful inquiries this was found impossible. Fortunately, while efforts were making to hire a dredge, the stream fell to its lowest stage. Scrapers were at once purchased and the work commenced. The low stage of water still continues, and the work is still going on. A full report will be given hereafter; but it must be remembered that we are liable at any time to have the work cut short by a rise in the stream. The only reliable method of conducting this improvement is by the use of a dredge, and to insure the improvement being completed as far as Tuscumbia will require an appropriation of the balance of the estimate for that purpose; that is, of $25,000.

Should a saving in the cost be effected by the use of scrapers the present season, or hereafter, the amount will be available for the improvement above Tuscumbia.

The supervision of this, as well as all similar works under my care, has been in the hands of Captain C. J. Allen, Corps of Engineers, who has been indefatigable in the discharge of his duties, and who is entitled to my thanks for the able manner in which he has aided me in my labors.

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

I 4.

OFFICE WESTERN RIVER IMPROVEMENTS,
No. 1122 *Pine Street, St. Louis, Missouri, October* 9, 1871.

GENERAL: I have the honor to submit this my annual report of operations upon the "Improvement of Ouachita River in Arkansas."

An examination of the Ouachita River, in the State of Arkansas, was made during the month of December, 1870, and the report, with estimates for the improvement of the same, amounting to $57,700, was submitted to the Bureau on the 4th of February, 1871.

The act of Congress approved March 3, 1871, made an appropriation "For the improvement of Ouachita River from the Louisiana State line to the town of Arkadelphia, in the State of Arkansas, on said river," of $25,000. The same act of Congress made an appropriation for the improvement of the river below the State line of Louisiana.

For the sake of economy, the expense of the outfit for making the improvement of the whole stream was divided between these two appropriations. Two flat-boats, one provided with steam-power, were purchased and fitted with cranes and hoisting apparatus and other requisite tools and implements for removing snags and trees, both from the bed of the river and its banks. All the arrangements for making the proposed improvements were completed previous to the 30th of June, or during the fiscal year for which reports are required.

The last session of Congress directed a survey of the Ouachita from Trinity, Louisiana, to Camden, Arkansas. From the fact that the report from this office forwarded February 4, 1871, expressed the belief that this portion of the Ouachita could be made navigable throughout the year at comparatively little expense, it was assumed that the survey was ordered to determine that point. A party is now in the field making the survey for that purpose, and a report thereon will be forwarded as soon as practicable.

PROPOSED OPERATIONS.

Since the completion of the outfit and other preliminaries, the two boats have been actively at work removing snags and other obstructions to navigation. The one without steam-power commenced work at Arkadelphia, and at last dates had nearly reached Camden. The other commenced at Camden, and at last dates was making good progress toward the State line.

Owing to the limited appropriation, it is not anticipated that all the snags and leaning trees can be removed from this stream the present season. My instructions have been to confine the work to such obstructions as were the most serious impediment to navigation, and to be careful not to leave any portion of the stream not passed over. From the reports of the amount of work done, as well as from persons interested in the commerce of the stream, I am satisfied that the navigation will be very materially improved by the operations of the present season. I propose to retain the boats, in hopes that Congress may, at its next session, make an appropriation for completing the improvement in as thorough a manner as was contemplated when the estimates were presented. This should be done, even if it was proposed hereafter to improve by locks and dams, as the present improvement consists only in removing snags and leaning trees, which would be as great obstructions after such improvement as at present.

The original estimates for the improvement of the Ouachita in Arkansas were	$57, 727
The amount appropriated was	25, 000
Leaving yet to be appropriated	32, 727

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

OFFICE WESTERN RIVER IMPROVEMENTS,
1122 *Pine Street, St. Louis, Missouri, October* 10, 1871.

GENERAL: I have the honor to submit my annual report upon the "Improvement of the Ouachita River, Louisiana, from the Arkansas State line to the mouth of said river."

The examination of the Ouachita River, in Arkansas, was ordered last season. The report thereon stated explicitly that no examinations were made below the State line of Louisiana. But the remark was made that the pilots reported four shoals below the State line, and that the river was full of snags. Upon this meagre data, an estimate was given of $26,000 for its improvement.

The act of Congress approved March 3, 1871, made an appropriation of $26,000 for the "Improvement of the Ouachita River, in Louisiana, from the Arkansas State line to the mouth of said river."

The survey now being made from Trinity, Louisiana, to Camden, Arkansas, for the purpose of determining the feasibility of improving the navigation of the Ouachita by locks and dams, will doubtless develop the true condition of the stream, and enable us to determine the best method of making such improvements as may be required.

PROPOSED OPERATIONS.

In my report upon the improvement of the Ouachita, in Arkansas, I stated that the cost of the outfit for the improvement of the whole stream had been divided between the two appropriations. Two flatboats (one with steam-power) were purchased and fitted with cranes, hoisting apparatus, and other appliances for removing snags and trees, both from the bed of the river and its banks. They are now at work above the State line. It is anticipated that they will reach the southern boundary of Arkansas about the 1st of December, when it is proposed they shall continue their operations as far as boats of that class can operate successfully.

After operations on the Mississippi, Missouri, and Arkansas Rivers are ended, it is proposed to send one of our snag-boats into the lower portion of the Ouachita, to work up until she meets the flat-boats coming down, and thus to have the whole navigable portion of the stream passed over, and if the bars are of such a character that they can be removed by the Long scraper it is proposed to send the dredge-boat Octavia to attempt their removal.

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, February 4, 1871.

GENERAL: I have the honor to forward the report of an examination, made under my direction, of the "Ouachita River," Arkansas.

The report divides the river into three sections, as follows:

1. From Rockport to Arkadelphia, forty-five miles.
2. From Arkadelphia to Camden, seventy-six miles.
3. From Camden to the State line, one hundred and thirty miles.

The law under which the examination was made directs surveys or examinations at "Ouachita River," Arkansas. Hence I gave instructions to end the work at the State line of Arkansas. Practically, however, this was of little effect, for before the party reached that section the river had risen so high as to prevent a minute examination and render it necessary to rely largely upon verbal statements; and a description of the stream below the State line was obtained from parties in the country, and is embodied in the report.

The first section, from Rockport to Arkadelphia, is above the "head of navigation," and would not have been examined but from the fact that the party first struck the stream at Rockport, and the examination from that place to Arkadelphia was made at little or no expense or loss of time. This portion of the stream is little more than a mountain torrent, at most times very shoal, and, when swollen, too rapid for navigation.

The question of the practicability of a lock and dam improvement may arise in the future, but that time has not yet come.

The section between Arkadelphia and Camden is only navigated by small boats, as there are several shoals upon which are but twelve inches of water at low stage. Dredging, in this section, would be of great benefit.

Large boats ply between New Orleans and Camden during about half the year. As the season of navigation corresponds with that for shipping cotton, and the country is entirely dependent upon the river for the transportation of all heavy freight, the importance of the proposed improvement is patent.

The method proposed for making the improvement of "Ouachita River" I think the most economical which can be pursued, and the estimates are, in the main, correct.

Nine months are, however, deemed necessary for that part of the river below Camden; it is evident, therefore, that the work cannot be done in one season of low water without the organization of two parties. This would require two outfits instead of one, as proposed, and would increase the cost so as to make the sum, in round numbers, $60,000.

Below the southern boundary of Arkansas the services of a snag-boat are greatly needed. As this portion of the river was not examined, we have no data upon which to base an estimate of the length of time which would be required; probably the work could be performed in two months, which would cost an additional $10,000.

Dredging the shoals in this stream would be of great benefit, not only by enabling boats to carry more freight, but also by lengthening the season of navigation, though it is not indispensable. If it is proposed to make all the improvement which would be desirable, the estimate for the improvement of Ouachita River would be as follows:

For removing obstructions between Arkadelphia and the southern boundary of Arkansas	$60,000
For the removal of snags between the southern boundary of Arkansas and the mouth of the river	10,000
For dredging below the southern line of Arkansas	16,000
For dredging between Arkadelphia and the southern line of Arkansas	12,300
Total	98,300

This is, perhaps, a suitable time for me to give my views in regard to the proper method of conducting the operations for the improvement of all the western rivers where the use of the snag-boats will be the best method of doing the work.

This duty requires at least two additional boats, built on a somewhat different plan from the ones we now have. They should not draw over two and a half feet of water, and be so constructed that they can work closer to shore than those we now have. The machinery should be as powerful as any now in use. All the snag-boats should be supplied with diving apparatus and other appliances for removing wrecks.

Estimates for two additional boats were submitted with report of October 10, 1870. An annual appropriation should, then, be made sufficiently large to keep *all* the boats running throughout the year; and the wording of the law, instead of being as at present, should be for the improvement of the "Mississippi River and its western tributaries." If this was the case, operations could be carried on throughout the entire year by taking advantage of the stage of water as it occurs in the extended field over which this duty extends.

Very respectfully, your obedient servant,

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

The third section reaches from Camden to the State line, one hundred and [illegible] miles.

The examination of the first section was made at a very low stage of water; so low, in fact, that I found it difficult to get over the bars and shoals with a small skiff drawing not more than 3 inches of water.

During the progress of the work on the second section the river rose 3 feet, which proved rather an advantage, as I had the opportunity of noting all the obstructions at that stage of water, the stage when small steamboats begin to run between Arkadelphia and Camden.

Before commencing the examination of the third section, the rainy season had set in and the river rose from 15 to 20 feet. Accordingly the observations were confined mostly to notes of the general character of the river, and of such obstructions to navigation as the stage of the water permitted. These notes were supplemented by information from the best pilots with whom I had the opportunity of consulting while I was at Camden.

The term "eddy," which will appear frequently in the subsequent notes, stands for "pool," and is in that sense universally used in that section of the country.

SECTION I.—*From Rockport to Arkadelphia, distance forty-five miles.*

Onachita River leaves the mountainous region of Hot Springs County at Rockport, and enters the bottom-lands, which spread out mostly on the left shore. The bottom-lands on the right shore are not more than two miles in width, and are bordered by the high uplands, which frequently strike the river-bank and accompany the same for several thousand feet. These bluffs are from forty to sixty feet high, and mostly covered with high pines. The uplands in the immediate neighborhood of the river consist either of sandy alluvial ground, or of red sandy and sometimes clay soil, while the bottom-lands have the deep alluvial soil, which, when it can be cultivated, is very productive.

On the left shore the upland terrace strikes the river in this section in but one place, about three miles above Arkadelphia. The bluff is from 40 to 50 feet high, and follows the shore for a distance of half a mile; is very steep, and consists of red clay underlaid by sandstone, which crops out half way up the bank.

The river in the upper two-thirds of this section is rapid, and partakes of the character of a mountain stream, as is shown by the devastation to which the adjacent country is subject at the time of high water, when the river overflows the banks, carrying trees, logs, and even rocks with it, depositing them in the middle of the bottom-lands, woods, and cane-brakes.

The course of the river exhibits a continual succession of shoals and eddies. From Rockport to the head of Watermelon Island—a distance of twenty miles by water—there are not less than fifteen shoals, and from Watermelon Island to Arkadelphia transportation of all heavy freight, the importance of the proposed improvement is patent.

The method proposed for making the improvement of "Ouachita River" I think the most economical which can be pursued, and the estimates are, in the main, correct.

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Very respectfully, your obedient servant,

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

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CHARACTER OF BANKS AND ADJACENT LANDS.

The valley of Ouachita has two terraces or levels. The upper terrace being secure against overflow, is generally cultivated, but, on account of the sandy soil, not very productive. The lower or true bottoms, bordering the river shore, are exposed to inundation during high-water season from 3 to 15 feet, but when they can be cultivated are immensely rich, producing annually 1,800 pounds of cotton in the seed, or from 70 to 80 bushels of corn, per acre.

The vegetation in the bottom is very rich and luxuriant, and among the timber is found the red and pin-oak swamp, chestnut-oak swamp, white oak, and even the beech, all of which attain a large size. On the upland the beech flourishes, attaining remarkable dimensions. When sandy soil is prevalent it is characterized by a luxuriant growth of pine, which grows also upon the alluvial sandy deposits of the river, even to the swampy banks. On the dry uplands there are also seen white and black oak in abundance, and of fine growth. On the left bank there is not a place in the immediate neighborhood of the river secure against overflow.

On the right bank, the uplands strike the river at the following points, forming bluffs generally covered by a rich growth of pine timber. These places are:

French Port, fourteen miles below Camden, 15 feet above overflow.

Warren's Hills, twenty miles below Camden, 30 feet above overflow.

Beech Hills, twenty-five miles below Camden, 30 feet above overflow.

These hills incline toward the shore at an angle of from 25° to 35°, are remarkable for fine growth of beech trees, and recede at Newport Landing, which is built on the lower end of this portion of the line of bluffs into the interior of the country.

Miller's Bluff, thirty-four miles below Camden, 50 feet above overflow, running along the river shore 2,000 feet, and covered with pine timber.

El Dorado Landing.—The hills are half a mile back from the shore, and bear the same character as above.

Champagnole Landing, fifty miles below Camden, bluff 125 feet high.

Wilmington, sixty-four miles below Camden, 100 feet high.

Pigeon Hill, seventy-one miles below Camden, 80 feet above high-water mark. Pigeon Hill is the last place where the high uplands touch the river shore; thence to the State line low, marshy bottom lands constitute the main features of the country.

There are several landings between this last-named point and the State line for the convenience of the trade with the uplands in the interior of the country. They consist only of warehouses built on stilts, the floors of which are from 15 to 20 feet above the ground.

From the Marie Saline Landing to the State line, a distance of twenty miles, the country on either side of the river is exposed to inundation from both the high water of Ouachita River and by that of the Mississippi during the regular overflow season. At Roland's Raft, a landing five miles above the State line, the floor of the warehouse is 16 feet above the ground, and in 1867 the water stood 3 inches deep on the floor, as I was informed by the one man tending the warehouse. As the banks here are about 20 feet above low-water mark the rise would be about 35 feet.

With the exception of the few landings, there is no sign of habitation on the river banks. Dense cane-brakes, cypress swamps, old river arms and lagoons are the principal features of the low marshy bottom.

THE OBSTRUCTIONS TO NAVIGATION,

in this section of the river, consist mainly of leaning timber and snags. The leaning timber, to the number of 32,690 trees, grows all along the shore; chiefly large willows and birch, with some sycamore and gum trees. On account of the narrowness of the river, and of its short turns, the leaning timber is a great impediment to navigation for such large boats as are used to ply during the high-water season between Camden and New Orleans. The high-water channel runs very close to the "points" in the short bends, and as the boat has to "pivot" around the point, her chimneys, rigging, and upper wood-work are always liable to come into collision with this leaning timber.

The number of snags seen at the time of the examination is 365, which number, I have no doubt, would be three times as high had the stage of the water permitted me to count all those lying in the river. Therefore, I do not consider my estimate too high when I place the number of snags at 1,000.

GENERAL REMARKS.

The most prominent shipping-points on the river in the State of Arkansas are Camden and Arkadelphia.

Arkadelphia commands the trade of a part of Pike, Clark, Hot Springs, and Dallas Counties, which depend altogether on the navigation of the river for shipping off the produce, and procuring supplies. As the time for navigating the river sets in, when cotton, the main staple product of the country, is getting ready for shipment, it is evi-

Tate's Bluff, forty-three miles below, is the next high ground. These bluffs are 200 feet high, and strike southeast for two miles, where they touch the river again at a single point, turning then southwest, and after meeting with the river shore once more, at Boiling Pot Rock, recede from the river entirely, and are not in sight again until two miles above Camden.

The air line from Tate's Bluff to Boiling Pot is four miles, while the distance by river is not quite ten miles.

On the left shore only one place is above overflow, viz, Manchester Landing, eleven miles below Arkadelphia; the bluff which runs alongside the shore for a mile is about 40 feet high. Although the bottom lands are submerged during the high-water season, yet there are a great many farms on both banks of the river, situated mainly on places where the lands are a few feet above the overflow of the regular high-water season. These farms are only inundated at extreme high water, which generally recedes into the proper river bed within two or three weeks. They are cultivated mostly in cotton, and partly in corn, and produce over one bale of cotton and 70 to 80 bushels of corn to the acre. The rest of the bottom land is covered with dense cane-brakes and valuable timber. The extreme low places are cypress swamps intersected by lagoons and bayous. The banks are from 20 to 25 feet above low water; the lowest strata are generally clay, and not subject to caving.

The bottom of the river bed is gravel on the shoals, and mud in the pools. The high-water season sets in generally about the 1st of December. Frequent rains in this latitude serve to maintain a fair stage of water during the winter season, until the spring freshets make their appearance and overflow the bottom lands. Low-water stage takes place by the middle of June, gradually getting down to the lowest stage in August and September, at which stage it remains until the rainy season sets in again, with the exception of a temporary rise of a few feet caused by rain-storms, which, however, disappear very quickly. Hence, navigation can be carried on only during the winter season.

From the nature and peculiar character of the stream it is evident that the manner of improvement will be different from what it is in the large western rivers, but as it will be similar to that of the lower river I will submit a plan for doing the work at the end of this report.

SECTION III.—*Camden to the State line; distance, one hundred and thirty miles.*

From Camden to the State line, between Arkansas and Louisiana, the river flows almost entirely through bottom lands which are subject to overflow.

The course of the river is very crooked. The width between banks changes frequently. From Camden to Marie Saline Landing, it varies from 300 to 500 feet, and in many places narrows to 250 feet between banks; so that the larger boats find it difficult to turn around. Thence to the State line, the average width between banks is 600 feet; at a medium stage of water there is plenty of room in the pools for boats to run; at low water the channel width varies between 100 and 200 feet. There are comparatively few shoals in this section of the river. They are as follows:

Names.	Distance from Camden.	Length of shoals.	Channel at low water.		Remarks.
			Width.	Depth.	
	Miles.	*Feet.*	*Feet.*	*Inches.*	
Hotcher's Shoals	4	300	45	15	Full of logs on the bottom.
Yeager's Towhead Shoals	7¼	250	48	18	
Long Point Shoal	12	245	40	22	
Spoon Camp Shoals	19	500	55	18	
Buffalo Flats	23	¼ mile	....	15	A flat blind bar extends over the whole width of the river.
Haydee Shoals	37½	400	50	20	
Slim Island Shoals	38½	500	65	15	
Enterprise Shoals	51	450	60	15	
Franklin Shoals	55	350	45	18	
Romeo Shoals	71	600	50	15	
Jack's Island	80	700	45	15	
Pine Prairie	85	400	55	22	
Paragythe	89	600	50	20	

CHARACTER OF BANKS AND ADJACENT LANDS.

The valley of Ouachita has two terraces or levels. The upper terrace being secure against overflow, is generally cultivated, but, on account of the sandy soil, not very productive. The lower or true bottoms, bordering the river shore, are exposed to inundation during high-water season from 3 to 15 feet, but when they can be cultivated are immensely rich, producing annually 1,800 pounds of cotton in the seed, or from 70 to 80 bushels of corn, per acre.

The vegetation in the bottom is very rich and luxuriant, and among the timber is found the red and pin-oak swamp, chestnut-oak swamp, white oak, and even the beech, all of which attain a large size. On the upland the beech flourishes, attaining remarkable dimensions. When sandy soil is prevalent it is characterized by a luxuriant growth of pine, which grows also upon the alluvial sandy deposits of the river, even to the swampy banks. On the dry uplands there are also seen white and black oak in abundance, and of fine growth. On the left bank there is not a place in the immediate neighborhood of the river secure against overflow.

On the right bank, the uplands strike the river at the following points, forming bluffs generally covered by a rich growth of pine timber. These places are:

French Port, fourteen miles below Camden, 15 feet above overflow.

Warren's Hills, twenty miles below Camden, 30 feet above overflow.

Beech Hills, twenty-five miles below Camden, 30 feet above overflow.

These hills incline toward the shore at an angle of from 25° to 35°, are remarkable for fine growth of beech trees, and recede at Newport Landing, which is built on the lower end of this portion of the line of bluffs into the interior of the country.

Miller's Bluff, thirty-four miles below Camden, 50 feet above overflow, running along the river shore 2,000 feet, and covered with pine timber.

El Dorado Landing.—The hills are half a mile back from the shore, and bear the same character as above.

Champagnole Landing, fifty miles below Camden, bluff 125 feet high.

Wilmington, sixty-four miles below Camden, 100 feet high.

Pigeon Hill, seventy-one miles below Camden, 80 feet above high-water mark. Pigeon Hill is the last place where the high uplands touch the river shore; thence to the State line low, marshy bottom lands constitute the main features of the country.

There are several landings between this last-named point and the State line for the convenience of the trade with the uplands in the interior of the country. They consist only of warehouses built on stilts, the floors of which are from 15 to 20 feet above the ground.

From the Marie Saline Landing to the State line, a distance of twenty miles, the country on either side of the river is exposed to inundation from both the high water of Ouachita River and by that of the Mississippi during the regular overflow season. At Roland's Raft, a landing five miles above the State line, the floor of the warehouse is 16 feet above the ground, and in 1867 the water stood 3 inches deep on the floor, as I was informed by the one man tending the warehouse. As the banks here are about 20 feet above low-water mark the rise would be about 36 feet.

With the exception of the few landings, there is no sign of habitation on the river banks. Dense cane-brakes, cypress swamps, old river arms and lagoons are the principal features of the low marshy bottom.

THE OBSTRUCTIONS TO NAVIGATION,

in this section of the river, consist mainly of leaning timber and snags. The leaning timber, to the number of 32,690 trees, grows all along the shore; chiefly large willows and birch, with some sycamore and gum trees. On account of the narrowness of the river, and of its short turns, the leaning timber is a great impediment to navigation for such large boats as are used to ply during the high-water season between Camden and New Orleans. The high-water channel runs very close to the "points" in the short bends, and as the boat has to "pivot" around the point, her chimneys, rigging, and upper wood-work are always liable to come into collision with this leaning timber.

The number of snags seen at the time of the examination is 365, which number, I have no doubt, would be three times as high had the stage of the water permitted me to count all those lying in the river. Therefore, I do not consider my estimate too high when I place the number of snags at 1,000.

GENERAL REMARKS.

The most prominent shipping-points on the river in the State of Arkansas are Camden and Arkadelphia.

Arkadelphia commands the trade of a part of Pike, Clark, Hot Springs, and Dallas Counties, which depend altogether on the navigation of the river for shipping off the produce and procuring supplies. As the time for navigating the river sets in, when [illegible] the country, is getting ready for shipment, it is evident that the unobstructed navigation of the river is of immense importance to the inhabitants.

The amount of cotton shipped from Arkadelphia annually is from 6,000 to 8,000 bales, which are carried to Camden by light-draught boats, and reshipped at that place for New Orleans.

Hempstead, Sevier, and the southwestern part of Pike County, which in former years shipped off their produce through Red River, are now dependent on the navigation of Ouachita River since the raft in Red River has closed again, and is impassable for boats. Thus, every bale of cotton from those counties has to be hauled in wagons to the nearest shipping point, viz, Camden, and by the same method all the supplies are carried back into the interior.

Camden thus commands the whole trade with all the counties lying west of it, as also with Cahoun County, and, through Arkadelphia, with those counties adjoining the upper section of the river.

Camden has large business houses, having an extensive trade. During the season of 1870 over 30,000 bales of cotton were shipped from that place to New Orleans, and the shipment during the present season is expected to exceed that of 1870.

The Governor Allen, a large steamer engaged during the summer season in the Vicksburg and New Orleans trade, made in 1870 twenty-one regular weekly trips between New Orleans and Camden, having had always a full cargo, exporting cotton and returning with groceries, dry goods, and all other supplies for the coming year. As an example of the flourishing trade that is carried on with the interior of the country it may be mentioned that one of the large business houses, and there are many in the place, has sold during the last year 20,000 barrels of flour.

The way-landings below Camden, viz, Warren's Hills, Beech Hills, Eldorado Landing, Champagnola, Wilmington, Pigeon Hill, and Currysville, on the right bank, and Little Bay, Moro Landing, and Marie Saline Landing, on the left bank, export annually from 1,000 to 3,000 bales of cotton each.

PLAN OF REMOVING THE OBSTRUCTIONS TO NAVIGATION.

The time for removing the obstructions to navigation, consisting principally of leaning timber and snags, is the low-water season, viz, from July to end of November.

At this time of the year all the snags are visible. No snag-boat of the western river service is adapted to the work of clearing out the obstructions in this river, and I am satisfied that the best and cheapest way to perform it will be as follows:

At the beginning of the low-water season a flat-boat can be built at the head of navgation sufficiently large to carry the working tools and camp outfit, and constructed in such a way that the draught when the boat is loaded will not exceed 12 inches. The equipment of this boat should consist of pulleys, hoisting-blocks, axes, saws, pick-axes, shovels, and the necessary rigging. An efficient mate, with a force of from fifteen to twenty men, good practical wood-choppers, start with this boat from the head of navigation, and work, under the directions of a civil engineer, down the river. The leaning timber should be cut up into pieces 10 to 12 feet long, so that when carried off by the high water these pieces cannot again form an obstruction. The snags on the shoals should be taken out entirely; those in deep water should be cut down below low-water mark. The dams, at the few places where they could be of benefit to throw the water into one channel, can be constructed of timber, brushwood, and gravel, the material for which is on the spot.

In order to avoid the trouble and inconvenience of provisioning the crew, I propose to make a contract with a caterer to pay a certain amount per head per day, which, estimated at the highest price, will not exceed $1, or to increase the wages of the crew and let them pay their own fare to the caterer.

Considering that the work has to be done during the unhealthy season, laborers command high wages, that is, from $2 to $3 per day, without board.

An efficient mate to work on the river is paid from $250 to $300 per month. The wages for the mate and a crew of twenty men for one month, computed at the highest rates, will be, therefore—

Wages of the mate, $10 per day, one month	$300
Wages of twenty men, $3 per day, one month	1,800
Total	2,100

TIME AND COST OF WORK ON THE SECTION BETWEEN ARKADELPHIA AND CAMDEN.

In this section there are 12,475 trees. As the trees have to be cut into pieces from 10 to 12 feet in length, the above crew can perform this work at the rate of 200 per day, making sixty-three days.

The snags can be cut down below low-water mark at the rate of twenty per day and will require fifty-three working days of the whole force. Building a brush-dam at Rams-horn Shoals will require four days' work. The same on left chute of Bear-head Island four days, and on Lower Wilhite Shoals five days, making thirteen days.

This will give you a total of one hundred and twenty-nine working days, allowing twenty-five working days per month, to five months and four days.

ESTIMATE OF COST.

Building of flat-boat	$1,000
Rigging and working tools	1,000
Fifty per cent. for repairs of tools	500
Wages of mate and crew for five months and four days, at $2,100 per month	10,780
Dredging 4,100 cubic yards, at $3 per yard	12,300
	25,580
Fifteen per cent. for contingencies	3,837
Total	29,417

TIME AND COST OF IMPROVEMENTS FOR THE SECTION FROM CAMDEN TO THE STATE LINE.

The number of trees to be cut amounts to 32,000, three-fourths of which are willows and birch, and below one foot in diameter. They can be cut at the rate of 200 per day, thus requiring one hundred and sixty working days; 1,000 snags, at the rate of 15 per day, will make sixty-six days, in all two hundred and twenty-six working days, equal to nine months. To do the work on the whole river in one season it will require the same outfit for this section, and the cost will be, therefore—

Flat-boat	$1,000
Rigging and working tools	1,000
Fifty per cent. for repair of tools	500
Wages of mate and crew for nine months, at $2,100 per month	18,900
	21,400
Fifteen per cent. for contingencies	3,210
Total	24,610

Both parties to be under the supervision of a civil engineer, at $300 per month, will give for nine months $2,700.

RECAPITULATION OF COST.

Salary of supervising engineer	$2,700
Estimate of cost for Section II	29,417
Estimate of cost for Section III	24,610
Total estimate of cost	56,727

APPENDIX.

The following data concerning Ouachita River, below the State line between Arkansas and Louisiana, I collected from the best pilots of that river while at Camden.

The principal bars below the State Line are:

Rock Roe, fifty-three miles below the State Line, has 20 inches of water upon it at low stages of the river.

Monroe Bar, below the old piers of the bridge burnt during the war. The bar is a "flat" extending over the whole width of the river, 300 feet long, and, during the dry season, has 15 inches of water upon it.

Taylor's Bar, forty miles below Monroe, 400 feet long, and at low water 20 inches depth of water.

Catahoola Shoals, at Harrisonburg, have, at low water, from 20 to 24 inches depth of water.

From Pine Prairie Shoals, in Arkansas, to the State line, and further on to Black River, thence to Red River, the stage of water depends materially upon that of the Mississippi River. A medium stage of water (10 feet) in the Mississippi will give 3 feet depth at Monroe bar, and a full stage of water (20 feet) will back the water up to the State line.

For excavating the channel at the above-named bars to a depth of 3 feet and 75 feet wide, I estimate that it will require the amount of $4,000 for each of these shallow places, making a total of $16,000 for the preliminary improvement of the river between the State line and Harrisonburg, Louisiana.

The overflow of the Mississippi reaches Pine Prairie Shoals, fifty-five miles above the State line.

Between Pine Bluff, forty-seven miles below Monroe and the mouth of Bœuf River, the Ouachita has a great many snags and sunken logs which, during low-water season, are dangerous.

It is the universal opinion of prominent steamboat men that Ouachita River could be made navigable all the year round by building four locks and dams, between Catahoola Shoals and Camden, for the use of boats drawing 3 feet water. The following are the places, where, according to their opinion, these locks and dams could be constructed, viz, at Catahoola Shoals, Taylor's Bar, (or Rock Roe,) in Louisiana, and Jack's Island, and Buffalo Flats, in Arkansas.

To ascertain this fact, an accurate survey of the river from Camden, Arkansas, to Trinity, Louisiana, at the confluence of the Ouachita, Tensas, and Little Rivers, would be necessary, and is recommended, as the navigation of Ouachita River is of the greatest importance to the States of Arkansas and Louisiana.

I am, very respectfully, colonel, your obedient servant,

JUSTIN STRASZER,
Civil Engineer.

Lieutenant Colonel W. F. Raynolds,
Corps of Engineers, U. S. A., St. Louis, Missouri.

APPENDIX I 5.

Office Western River Improvements,
St. Louis, Missouri, February 9, 1871.

General: I have the honor to inclose herewith a report of the examination of the "Little Missouri River," in Arkansas, a tributary of the Ouachita.

This stream proves, on examination, to be one of the important minor streams which can be made navigable by suitable improvement.

The narrow channel contains numerous snags which should be removed, and the overhanging trees which now impede the passage of boats should be taken away. This done, and a few small improvements made in the channel, and the stream will be navigable during the winter months, which is the important period for disposing of the produce of the country. The length of the navigable portion of the river is estimated at sixty-eight miles, and the estimated cost of the required improvements is $23,000.

The direct line from the head of navigation to the junction with Ouachita is about half the distance between these points, measured by the river; country adjacent to the river is among the most fertile of the cotton districts of the South.

The proposed improvements are such that, the work once done, the navigation would remain unobstructed for a long time, if not permanently; the few snags which might lodge in the stream afterward could be readily removed by the annual visit of a snag-boat.

The importance of affording every facility for bringing the staple product of this region (cotton) to market, is too manifest to require discussion.

Very respectfully,

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. Humphreys,
Chief of Engineers, U. S. A., Washington, D. C.

ST. LOUIS, MISSOURI, *February* 2, 1871.

SIR: I have the honor to submit herewith my report on the examination of "Little Missouri River," in the State of Arkansas.

The river rises in the mountainous region of the northwest corner of Pike County; the general course of the river is southeast, and very crooked from its head to its confluence with the Ouachita.

The principal tributaries are Ozan, Terre-Rouge, and Cypress Creek, on the right bank, and the Antoine and Terre-Noire on the left. Besides these, there are a number of small mountain streams.

Natchitoches Bluff, below the mouth of Antoine Creek, is regarded as the head of steamboat navigation. From this point to the confluence with Ouachita River, a distance of sixty-eight miles, the river greatly resembles White River in its general features, although it is much smaller. The turns and bends are short, and have between them frequent stretches from one to two miles in length, commonly called the "eddies."

The average width of the river between banks is 300 feet, yet, in many places, especially at very short turns, the width approaches 400 feet.

The channel in the pools or "eddies" is from 100 to 150 feet wide, and from 5 to 15 feet deep at low water.

This river has comparatively few shoals, and would be altogether a better stream for navigation than Ouachita River is from Arkadelphia to the confluence, provided the obstructions are removed.

The following are the principal shoals between Natchitoches Bluff and the mouth, and located by distance from the former point:

Grayson's Fishtrap Shoals, one mile. The river here divides into two channels, the left of which is the main channel, 75 feet wide, and 15 inches deep at low water. The right channel, 30 feet wide, and 3 feet deep, carries off most of the water. These shoals, 400 feet long, have a fall of 1.50 feet, and can be improved by closing up the right channel with a brush-dam, and by destroying the Fishtrap dams

The shoals at the foot of Paley's Eddy, four and a half miles below Natchitoches Bluff, 500 feet long, fall 1 foot. The steamboat channel next to right shore is 80 feet wide, and 18 inches deep at low water. The only obstructions at this place are the leaning trees.

Gasney's Ford, seven miles, 200 feet long, with 0.75 foot fall. The channel is 100 feet wide, and 24 inches deep at low water.

Dead Birch Shoals, twelve miles below Natchitoches Bluff, 500 feet long, 1.75 feet fall. The right-hand chute is the main channel, 60 feet wide, and 20 inches deep in low water.

McClellan's Ford, sixteen miles; a flat bar, 300 feet long, and extending over the whole width of the river, which is 300 feet wide between banks. At low water the depth is 18 inches.

Price's Shoals, twenty-four miles; large gravel bar in the middle of the river, 500 feet long, and 150 feet wide. The left chute, 200 feet wide, is the main channel, having 15 inches depth at low water by a channel-width of 75 feet; fall 1.50 feet.

Raccoon Bridge Shoals, twenty-eight miles. The river is divided into three channels; the main chute running along the left shore is 600 feet long, has 80 feet channel-width, and 18 inches depth at low water; fall 1.75 feet.

Long Island, thirty-seven miles. This island is three-fourths of a mile long. The right chute, 150 feet wide, is the main channel, and has at low water 20 inches depth. The left arm, 100 feet wide, can be closed by a brush-dam, in order to throw the whole quantity of water into the main channel.

Bloody Cypress Shoals, forty miles. The shoals are 350 feet long, and have a fall of 1.5 feet. The channel is 100 feet wide, and has 20 inches depth at low water.

Tate's Ford, forty-five miles. The length of shoals is 400 feet, with 1 foot fall. The channel is 75 feet wide, and 24 inches deep in low water.

Gun Shoals, fifty miles. The channel width is 60 feet, with 15 inches depth. The shoals are 250 feet long, and have 1 foot fall.

Dickens's Ford, fifty-three miles, a flat gravel bar, extending over the whole width of the river. The depth at low water is from 15 to 20 inches.

Heart's Island, fifty-five miles. The left chute, one mile in length, is the steamboat channel, from 150 to 200 feet wide, and has twenty-four inches on the shallowest place. The right chute, called "Fool River," could be closed by a brush wing-dam, 100 feet long, in order to throw all the water into the main channel.

Hill's Defeat and Cut-Off.—There is plenty of water in the regular channel following the bend. The cut-off is 300 feet long, across the neck; could be made the main channel by excavating, and cleaning out the snags. There is 15 inches depth in the cut-off at low water.

Chafalara Chute, two miles above the mouth. This cut-off is 100 feet wide, and 500 feet long, and has 12 inches depth at low water. The distance around the bend is half a mile; excavating the gravel and a brush-dam would make the chute the main channel. The current in the pools is very slight, and varies between one and a half and two miles running between gravel bars, the main channel being 60 feet wide, with 12 inches of water.

One mile below the mouth of Caddo Creek, a flat shoal, 2,000 feet long, extending over the whole width of the river, has from 6 to 18 inches depth.

Three miles above Arkadelphia, at the foot of Osborn Eddy, several flat, marshy islands, covered with willows and birch, extend half a mile in length between the left shore and the main channel. The channel on these shoals, called Osborn's Shoals, is at the upper end 100 and at the lower end 200 feet wide, and from 18 to 24 inches deep.

CHARACTER OF THE BANKS AND RIVER-BED.

The bottom of the river-bed consists of gravel throughout this portion of the river. The bed is covered with boulders, many of which are very large.

The banks along the bottom lands are from 15 to 25 feet high, firm, and not subject to caving. Where the high uplands strike the river, the lowest strata of the bluffs expose rocky ledges, which crop out frequently and form, at times, part of the river-bed. The upper layers are generally composed of a stiff red or blue clay, mixed with sand. Overhanging trees are found all along the river, and snags and sunken logs abound on all the shoals.

The bottom-lands are subject to overflow in high water, from 2 to 10 feet, and are mostly covered with heavy timber and dense cane-brakes. There are but few tracts of cleared land in the immediate neighborhood of the river. The high uplands, consisting principally of sandy soil, are not very productive, and mostly covered with pine forests.

HIGH WATER.

High water is caused only by rains in the mountain region; such a rise, properly called a freshet, appears very suddenly, the stream sometimes rising within twelve hours from 15 to 20 feet, and lowering as many feet in twenty-four hours after the rain ceases. These freshets have a very rapid current, as indicated by the large gravel bars, and by the immense amount of drift-wood which is deposited in the woods. The current, in such cases, cuts across the necks of the crooked bends, leaving the river-bed entirely; the result is frequent changes of the channel after high water, the flood carrying away gravel bars and depositing the same in other places.

The rapidity of the current at high water is such that boats, otherwise adapted for the navigation of the stream, could not stem it; the small extent to which the country is cultivated and the general scarcity of water in the stream do not justify any expenditure of money in attempting to improve this section; consequently, no estimate has been made for this portion.

SECTION II.—*Arkadelphia to Camden, distance seventy-six miles.*

Arkadelphia is the head of steamboat navigation, which is carried on during the winter season between this port and Camden. Light draught-boats run generally from December to the month of June. The river, having fairly entered the bottom-lands, changes its character, and although there are still many shoals, yet these places do not cover as much space as in the section above, there being, on an average, a wider channel and more water.

The following table will exhibit the most prominent shoals, giving the names, the location, dimensions, and propositions for improving each of them by the method of excavating and deepening the shallowest places in the channel.

Below the mouth of Little Missouri River—which empties into Ouachita River forty-three miles below Arkadelphia, and is the largest tributary on the right shore—the shoals diminish in number; the pools between them are long, and on an average 500 feet wide, and at low water 5 feet deep and over.

Shoals between Arkadelphia and the mouth of the Little Missouri River.

Names.	Distance from Arkadelphia.	Length of shoals.	Width of river between banks.	Channel at low water.		Fall in feet.	Cubic yards of gravel to be excavated.	Cost of excavation at $3 per cubic yard.	Remarks.
				Width.	Depth.				
	Miles.	*Feet.*	*Feet.*	*Feet.*	*In.*				
Big Willow	6½	350	400	80	22	0.5	......	......	
Parker's Defeat	7½	500	300	80	22	1.00	......	......	
L'eaufrais Shoals	10	500	200	75	18	1.00	600	$1,800	
Open Banks	13	600	250	75	20	1.25	......	......	
Gourdwine Shoals	15	900	400	100	12	1.50	800	2,400	
Cassemasso Shoals	18½	1,000	600	100	12	2.00	900	2,700	
Hudson's field	21½	400	500	50	18	0.75	200	600	
Beaver Lake Shoals	24	150	300	75	12	0.50	300	900	
Thunder Struck	25	400	500	75	18	0.75	......	......	
Steel's Bar	26½	300	300	100	24	0.50	......	......	
Decepier Shoals	27½	400	300	100	22	0.50	......	......	
Upper Little Hill	29½	700	600	75	12	1.50	600	1,800	
Ram's-horn Shoals	34	900	00	75	18	2.50	400	1,200	To throw the water into one channel, will require a brush-dam 100 feet long.
Right chute at Bear Head Island	35	400	500	75	12	1.50	300	900	To close the left chute will require wing-dam 125 feet long.
Pin Hook	41	300	600	75	22	0.75	......	......	
Total	......	......	......	......	......	......	4,100	12,300	

Shoals below the mouth of Little Missouri River.

Names.	Distance in miles.	Length of shoals.	Width of river between banks.	Channel at low water.		Fall in feet.	Remarks.
				Width.	Depth.		
		Feet.	*Feet.*	*Feet.*	*In.*		
Point Coupé	4	400	800	100	24	1.00	
Rapids	6½	300	500	100	24	1.75	
Boiling Pot Shoals	9½	400	500	150	24	1.50	
Pikes Chute	10½	800	600	100	20	2.00	
Bayou Frio Shoals	21	300	400	75	24	1.00	
Crow Foot	22	400	400	100	20	1.00	
Upper Wilhite	23½	600	400	150	18	1.25	
Lower Wilhite	24	600	800	100	20	2.00	Brush wing-dam, 100 feet long, to throw the water into the main channel.

Excavating and deepening the channel on the shoals would be of great benefit to the navigation, but it is not absolutely necessary to do this.

The greatest and most dangerous obstruction to the navigation consists of leaning timber and the great number of logs and snags lying in the channel. The aggregate number of trees in this is 12,475, two-thirds of which belong to the species of willow and birch, and are less than one foot in diameter. The snags and logs are 1,053 in number.

CHARACTER OF THE ADJOINING COUNTRY.

The river follows, between the two ports, a very winding course, and flows almost entirely through bottom lands. The high uplands, touching the river at Arkadelphia, recede from the stream, and strike the same again for the first time, thirty-two miles below that city, at Little Hill, a bluff about half a mile long.

timber, and an estimate was given of the cost of their removal, amounting to $23,000.

The act of Congress approved March 3, 1871, made an appropriation "For the improvement of the Little Missouri River in Arkansas," $10,000.

As soon as practicable after the passage of the appropriation, a suitable flat-boat was procured and fitted with all the necessary appliances for removing snags from the bed of the stream and cutting timber from its banks.

The appropriation being less than half of the estimated cost of removing all the obstructions which existed, the question was presented, what is the best way to expend the means which are available? If we should attempt to do thorough work and remove all obstructions, only a portion of the stream would be passed over, and while the remaining portion remained untouched, the benefit to commerce would be little or nothing; on the other hand, if the worst obstructions could be removed from the whole length of the stream, this improvement, though not what it should be, would still be decided and available; and should Congress fail to make an additional appropriation, the work done would not be lost. These considerations have caused me to aim to have the whole stream passed over, which, it is believed, we will be able to do, and from the reports received from the party, I am convinced that the aid to commerce will be very decided; still there will remain many obstructions which should be removed, and I propose to retain the outfit in hopes that Congress at its next session will make an additional appropriation for the purpose of completing the improvement in the manner contemplated in the original report.

A report of the amount of work done cannot be made now, but will be submitted hereafter.

The original estimate for the improvement of the Little Missouri River in Arkansas was	$23,000
Amount appropriated	10,000
Leaving to complete the work yet to be apppropriated	13,000

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

I 6.

OFFICE WESTERN RIVER IMPROVEMENT,
St. Louis, Missouri, February 11, 1871.

GENERAL: The report on "Petit Jean River," which is forwarded herewith, shows that stream to be so obstructed by drift-wood and leaning trees upon the banks as to render its improvement a formidable undertaking when the importance of the stream and the amount of commerce is considered.

The improvement of the lower portion of the river, without removing the logs in the upper portion, could be of little permanent benefit, as the drift-wood left remaining would probably float down, and again obstruct the navigation.

That the navigation could be improved in the way proposed, and for the amount of the estimate, ($68,400,) I have no reason to doubt; but whether the necessities of the case call for such an expenditure, is, in my opinion, a question which, to say the least, is debatable.

Very respectfully,

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

ST. LOUIS, MISSOURI, *February* 6, 1871.

SIR: I have the honor to submit herewith my report on the examination of "Petit Jean River," in the State of Arkansas.

The river rises in the western part of Scott County, enters Sebastian County as a small creek, and turning westward traverses Scott and Yell counties in a very winding course, and empties into Arkansas River sixteen miles above Lewisburg. The tributaries of the Petit Jean are small mountain streams, rising in the range of Petit Jean Mountains and its spurs, and are very short; the principal of which are Sugar Creek and Dutch Creek above Danville, and Rose Creek twenty-one miles above the mouth of the river.

From the fact that a small steamboat once reached Danville, this place is regarded as the head of navigation on the river. The distance from Danville to the mouth is seventy-eight miles.

From Danville to Rocky Crossing, thirty-seven miles by water, the river is a wild mountain stream.

The general width between banks varies from 100 to 250 feet, but is, in many places, less than 100. The course of the river in this part exhibits a succession of pools and shoals. The channel in the pools is from 50 to 100 feet wide, and had, at the time of the examination, from three to eight feet depth and over. These figures, no doubt, would be lessened considerably if the water could flow without obstruction.

The following is a table of the most prominent shoals:

Names.	Distance from Danville.	Width of river between banks.	Length of shoals.	Channel at low water.		Fall.	Remarks.
				Width.	Depth.		
	Miles.	*Feet.*	*Feet.*	*Feet.*	*In.*	*Ft.*	
Low Ford	3	175	200	100	24	....	Flat gravel bar extending over the whole width of the river.
Milkens's Fish-trap	4½	150	400	25	10	2½	Gravel bar in the middle of the river. Left chute is the main channel—right chute filled with drift-wood.
(No name)	9	100	300	30	12	....	Flat gravel bar.
(No name)	13	200	250	75	15	....	Flat gravel bar.
Island Crossing Shoals	17	400	800	30	6	4½	Two islands in the middle of the river. The lower one, covered with high timber, is 300 feet long and 100 feet wide, the upper is merely a gravel bar covered with willows and birch. The wide chutes constituting the high-water channel are filled with drift-wood piled up 15 feet high.
(No name)	18	100	400	50	10	....	Flat gravel bar.
Slaty Crossing	19	175	700	25	4	5½	Slate rock along the left bank. Gravel bar in the middle of the river 50 feet wide and 206 feet long, covered with willows. Right chute filled with drift-wood.
Rocky Crossing	37	200	400	50	6	2½	Rocky ledges along the right bank near the water's edge. Large boulders in the river-bed over the whole width.

Between the last two shoals there are seven drift-piles which fill up the whole river-bed, five of which have a length varying between 200 and 500 feet, and the remaining two are, respectively, 70 and 100 feet long.

From Rocky Crossing to "Dardanelle, or Hot Spring Crossing," a distance of five miles, the river is very narrow, the width between banks ranging from 75 to 125 feet. The channel width, in this part, varies between 20 and 50 feet at low water, and has from 15 inches to 5 feet depth.

From three miles below Dardanelle Crossing to the mouth of the river, the stage of water was controlled by that existing in the Arkansas River, which I afterward learned in Lewisburg was, at that time, 7 feet above its lowest stage.

From the soundings taken while pursuing the examination, it appears that the lowest depth noted was 8 feet; hence at low water there are a few places with but 12 inches depth. These are, respectively, twelve, fifteen, eighteen and one-half, twenty-three, and thirty miles below Rocky Crossing, and are merely flat bars extending over the whole width of the river, and varying in length from 100 to 250 feet. The width of the river from Dardanelle Crossing to the mouth ranges from 150 to 350 feet between banks; the channel width from 75 to 150 feet.

There is hardly any current in the pools, while on the shoals it is very rapid.

CHARACTER OF THE ADJACENT COUNTRY.

From Danville to the mouth the river flows almost entirely through bottom lands, which exhibit two terraces or levels. The lower terrace is exposed to inundation and not cultivated, but merely used as a stock range. The upper terrace on the right bank is formed by the hilly uplands and spurs from the Petit Jean Mountains, a range which runs almost due east between Petit Jean and Fourche La Fave Creek to the boundary line between Yell and Perry counties, turning thence northeast, and touches the river about five miles above its mouth, and follows it to the junction with the Arkansas.

The height of this range is about 1,200 feet above the level of the Arkansas River. The declivities are very steep; the barren rocks crop out everywhere and form picturesque scenes in connection with the fine pine forests, which cover the mountains over the entire slope. The spurs run out toward the river in very broad ridges, dividing small water-courses.

These ridges are covered with valuable timber, exhibiting a great variety of oaks, chestnut, and blackjack, and wherever the latter species is abundant it indicates good, rich land. Between Danville and Rocky Crossing there are only five points where the high upland terraces come in contact with the river, which, after meeting with the bluff, turns back to the low grounds in a winding course. These bluffs are from 40 to 50 feet high above low-water mark. On the left bank the upper terrace is formed of long broad ridges, which meet the river shore only in two places.

Twelve miles above the mouth the lands through which the river flows partake of the character of the land bordering the Arkansas River, consist of rich alluvial soil, and although inundated during extreme high water are cultivated to a great extent. The same is the case on the right bank, between the mountains and the river, yet this side is, on account of the more sandy soil, not as productive as the former. The banks are from 10 to 20 feet high above low water, and not subject to caving.

During the high-water seasons, that is, both from a head-rise as also from the backwater of the Arkansas River, the low bottom lands are overflowed from 3 to 10 feet; dense cane-brakes and swamps are the main features of the bottom lands, which are intersected by sloughs and bayous. These sloughs running across the necks of the bends are generally filled with drift-wood, indicating that the rapid current of the stream then leaves the river bed, and takes a straight course through the woods.

The high water originating from a head-rise appears very suddenly, but never lasts very long; the highest water known at Danville was 28 feet above low water, reaching to the top of the trestle-bridge which is built across the river.

The only stage of water on which navigation could depend is the backwater from Arkansas River, as long as the latter keeps up; the last rise of 7 feet backed up thirty-three miles from the mouth. It will require a rise of 15 feet in Arkansas River to give 2 feet depth at Rocky Crossing, and a rise of 35 feet to have 2 feet water at Danville.

Generally, three floods occur in Arkansas River during the year—the first in January or February, the second in June and July, and the third in November; the highest is that of June and July, and is called the "big or red rise." The stage of water in ordinary floods is 28 feet above low-water mark; in the year 1844 the rise was 45 feet, which was the highest water ever known.

OBSTRUCTIONS TO NAVIGATION—IMPROVEMENTS AND COST THEREOF.

Besides the drift-wood in the river bed already mentioned, the obstructions to navigation consist of leaning timber and snags.

The leaning trees are, throughout the entire course of the river, on both banks, and grow from low-water edge up; where the river is very narrow, their branches meet above.

From Danville to Rocky Crossing there are 24,028 trees and 478 snags; about half of the number of trees are below one foot in diameter, and belong mostly to the species of willow and birch, with some sycamore, elm, and gum trees.

From Rocky Crossing to the mouth there are 36,197 trees and 643 snags.

In clearing the river of obstructions, it will be necessary not only to fell these leaning trees, but also to haul them up on the banks for some distance, as the width between banks is very small, and the trees, otherwise, would be apt to roll into the channel, and choke it up again.

To carry out the improvements, the same plan is proposed as in the case of Ouachita River—by employing a force of one mate and twenty wood-choppers in cutting timber, hauling out, and depositing the pieces on the bank. The average day's work will be 100 trees removed; snags can be cut down to low-water mark at the rate of 15 per day.

The section from Danville to Rocky Crossing would thus require 273 working days for cutting timber and snags.

The only way to get rid of the drift-piles is to set them on fire when they are dry; and when the river is very low, the débris that will not burn will have to be removed by hauling them out on the banks. It is not easy to calculate how much of this débris will remain, or how long it will take to remove it.

From Rocky Crossing to the mouth the leaning timber is mostly small birch and willows, half of which measuring not more than 6 inches in diameter, and can be disposed of at the rate of 150 per day, and the snags, as in the former section, at the rate of 15 per day; this will require 286 working days.

COST.

Building flat-boat to carry camp outfit	$500 00
Working tools and rigging	2,000 00
Fifty per cent. for repair of tools	1,000 00
Total	3,500 00

1st section:

273 working days, at 25 days per month, will be 11 months; wages of mate and crew, at $2,100 per month, for 11 months	$23,100 00
Thirty per cent. of this sum for contingencies, on account of drift-piles	6,930 00
Total	30,030 00

2d section—from Rocky Crossing to the mouth:

286 working days will give, as above computed, 11½ months, at $2,100 per month, for wages of mate and crew	$24,150 00
Fifteen per cent. of this sum for contingencies	3,622 00
Total	27,772 00

RECAPITULATION OF COST.

Salary of supervising engineer for 12 months	$3,600 00
Boat and working tools for Section I	3,500 00
Boat and working tools for Section II	3,500 00
Cost of Section I	30,030 00
Cost of Section II	27,772 00
Total	68,402 00

GENERAL REMARKS.

Danville, the county seat of Yell County, is a small village, with a population of about three hundred souls, and is altogether insignificant, having no commerce nor trade. The produce of the country consists chiefly of cotton and corn, which is hauled in wagons to Dardanellé, the next shipping point on Arkansas River, a distance of twenty-two miles. The most productive land lies between Danville and the Arkansas River, on the broad ridges projecting from the Magazine Mountain, but even there the country is very thinly settled; south of Petit Jean River the high mountain range is not fit for cultivation, and is only valuable for its extensive pineries. Only a few farms are scattered along the right bank, between the river and the mountains; those farms situated between the Petit Jean and Arkansas Rivers are almost as near to the Arkansas as to the former.

running between gravel bars, the main channel being 60 feet wide, with 12 inches of water.

One mile below the mouth of Caddo Creek, a flat shoal, 2,000 feet long, extending over the whole width of the river, has from 6 to 18 inches depth.

Three miles above Arkadelphia, at the foot of Osborn Eddy, several flat, marshy islands, covered with willows and birch, extend half a mile in length between the left shore and the main channel. The channel on these shoals, called Osborn's Shoals, is at the upper end 100 and at the lower end 200 feet wide, and from 18 to 24 inches deep.

CHARACTER OF THE BANKS AND RIVER-BED.

The bottom of the river-bed consists of gravel throughout this portion of the river. The bed is covered with boulders, many of which are very large.

The banks along the bottom lands are from 15 to 25 feet high, firm, and not subject to caving. Where the high uplands strike the river, the lowest strata of the bluffs expose rocky ledges, which crop out frequently and form, at times, part of the river-bed. The upper layers are generally composed of a stiff red or blue clay, mixed with sand. Overhanging trees are found all along the river, and snags and sunken logs abound on all the shoals.

The bottom-lands are subject to overflow in high water, from 2 to 10 feet, and are mostly covered with heavy timber and dense cane-brakes. There are but few tracts of cleared land in the immediate neighborhood of the river. The high uplands, consisting principally of sandy soil, are not very productive, and mostly covered with pine forests.

HIGH WATER.

High water is caused only by rains in the mountain region; such a rise, properly called a freshet, appears very suddenly, the stream sometimes rising within twelve hours from 15 to 20 feet, and lowering as many feet in twenty-four hours after the rain ceases. These freshets have a very rapid current, as indicated by the large gravel bars, and by the immense amount of drift-wood which is deposited in the woods. The current, in such cases, cuts across the necks of the crooked bends, leaving the river-bed entirely; the result is frequent changes of the channel after high water, the flood carrying away gravel bars and depositing the same in other places.

The rapidity of the current at high water is such that boats, otherwise adapted for the navigation of the stream, could not stem it; the small extent to which the country is cultivated and the general scarcity of water in the stream do not justify any expenditure of money in attempting to improve this section; consequently, no estimate has been made for this portion.

SECTION II.—*Arkadelphia to Camden, distance seventy-six miles.*

Arkadelphia is the head of steamboat navigation, which is carried on during the winter season between this port and Camden. Light draught-boats run generally from December to the month of June. The river, having fairly entered the bottom-lands, changes its character, and although there are still many shoals, yet these places do not cover as much space as in the section above, there being, on an average, a wider channel and more water.

The following table will exhibit the most prominent shoals, giving the names, the location, dimensions, and propositions for improving each of them by the method of excavating and deepening the shallowest places in the channel.

Below the mouth of Little Missouri River—which empties into Ouachita River forty-three miles below Arkadelphia, and is the largest tributary on the right shore—the shoals diminish in number; the pools between them are long, and on an average 500 feet wide, and at low water 5 feet deep and over.

Shoals between Arkadelphia and the mouth of the Little Missouri River.

Names.	Distance from Arkadelphia.	Length of shoals.	Width of river between banks.	Channel at low water.		Fall in feet.	Cubic yards of gravel to be excavated.	Cost of excavation at $3 per cubic yard.	Remarks.
				Width.	Depth.				
	Miles.	*Feet.*	*Feet.*	*Feet.*	*In.*				
Big Willow	6½	350	400	80	22	0.5	......	....	
Parker's Defeat	7¼	500	300	80	22	1.00	......	....	
L'eaufrais Shoals	10	500	200	75	18	1.00	600	$1,800	
Open Banks	13	600	250	75	20	1.25	......	....	
Gourdwine Shoals	15	900	400	100	12	1.50	800	2,400	
Cassemasso Shoals	18¼	1,000	600	100	12	2.00	900	2,700	
Hudson's field	21½	400	500	50	18	0.75	200	600	
Beaver Lake Shoals	24	150	300	75	12	0.50	300	900	
Thunder Struck	25	400	500	75	18	0.75	......	....	
Steel's Bar	26½	300	300	100	24	0.50	......	....	
Decepier Shoals	27½	400	300	100	22	0.50	......	....	
Upper Little Hill	29½	700	600	75	12	1.50	600	1,800	
Ram's-horn Shoals	34	900	00	75	18	2.50	400	1,200	To throw the water into one channel, will require a brush-dam 100 feet long.
Right chute at Bear Head Island	35	400	500	75	12	1.50	300	900	To close the left chute will require wing-dam 125 feet long.
Pin Hook	41	300	600	75	22	0.75	......	....	
Total	......	......	......	......	......	......	4,100	12,300	

Shoals below the mouth of Little Missouri River.

Names.	Distance in miles.	Length of shoals.	Width of river between banks.	Channel at low water.		Fall in feet.	Remarks.
				Width.	Depth.		
		Feet.	*Feet.*	*Feet.*	*In.*		
Point Coupé	4	400	800	100	24	1.00	
Rapids	6¼	300	500	100	24	1.75	
Boiling Pot Shoals	9½	400	500	150	24	1.50	
Pikes Chute	10½	800	600	100	20	2.00	
Bayou Frio Shoals	21	300	400	75	24	1.00	
Crow Foot	22	400	400	100	20	1.00	
Upper Wilhite	23½	600	400	150	18	1.25	
Lower Wilhite	24	600	800	100	20	2.00	Brush wing-dam, 100 feet long, to throw the water into the main channel.

Excavating and deepening the channel on the shoals would be of great benefit to the navigation, but it is not absolutely necessary to do this.

The greatest and most dangerous obstruction to the navigation consists of leaning timber and the great number of logs and snags lying in the channel. The aggregate number of trees in this is 12,475, two-thirds of which belong to the species of willow and birch, and are less than one foot in diameter. The snags and logs are 1,053 in number.

CHARACTER OF THE ADJOINING COUNTRY.

The river follows, between the two ports, a very winding course, and flows almost entirely through bottom lands. The high uplands, touching the river at Arkadelphia, recede from the stream, and strike the same again for the first time, thirty-two miles below that city, at Little Hill, a bluff about half a mile long.

Tate's Bluff, forty-three miles below, is the next high ground. These bluffs are 200 feet high, and strike southeast for two miles, where they touch the river again at a single point, turning then southwest, and after meeting with the river shore once more, at Boiling Pot Rock, recede from the river entirely, and are not in sight again until two miles above Camden.

The air line from Tate's Bluff to Boiling Pot is four miles, while the distance by river is not quite ten miles.

On the left shore only one place is above overflow, viz, Manchester Landing, eleven miles below Arkadelphia; the bluff which runs alongside the shore for a mile is about 40 feet high. Although the bottom lands are submerged during the high-water season, yet there are a great many farms on both banks of the river, situated mainly on places where the lands are a few feet above the overflow of the regular high-water season. These farms are only inundated at extreme high water, which generally recedes into the proper river bed within two or three weeks. They are cultivated mostly in cotton, and partly in corn, and produce over one bale of cotton and 70 to 80 bushels of corn to the acre. The rest of the bottom land is covered with dense cane-brakes and valuable timber. The extreme low places are cypress swamps intersected by lagoons and bayous. The banks are from 20 to 25 feet above low water; the lowest strata are generally clay, and not subject to caving.

The bottom of the river bed is gravel on the shoals, and mud in the pools. The high-water season sets in generally about the 1st of December. Frequent rains in this latitude serve to maintain a fair stage of water during the winter season, until the spring freshets make their appearance and overflow the bottom lands. Low-water stage takes place by the middle of June, gradually getting down to the lowest stage in August and September, at which stage it remains until the rainy season sets in again, with the exception of a temporary rise of a few feet caused by rain-storms, which, however, disappear very quickly. Hence, navigation can be carried on only during the winter season.

From the nature and peculiar character of the stream it is evident that the manner of improvement will be different from what it is in the large western rivers, but as it will be similar to that of the lower river I will submit a plan for doing the work at the end of this report.

SECTION III.—*Camden to the State line; distance, one hundred and thirty miles.*

From Camden to the State line, between Arkansas and Louisiana, the river flows almost entirely through bottom lands which are subject to overflow.

The course of the river is very crooked. The width between banks changes frequently. From Camden to Marie Saline Landing, it varies from 300 to 500 feet, and in many places narrows to 250 feet between banks; so that the larger boats find it difficult to turn around. Thence to the State line, the average width between banks is 600 feet; at a medium stage of water there is plenty of room in the pools for boats to run: at low water the channel width varies between 100 and 200 feet. There are comparatively few shoals in this section of the river. They are as follows:

Names.	Distance from Camden.	Length of shoals.	Channel at low water.		Remarks.
			Width.	Depth.	
	Miles.	*Feet.*	*Feet.*	*Inches.*	
Hotcher's Shoals	4	300	45	15	Full of logs on the bottom.
Yeager's Towhead Shoals	7¼	250	48	18	
Long Point Shoal	12	245	40	22	
Spoon Camp Shoals	19	500	55	18	
Buffalo Flats	23	¼ mile	....	15	A flat blind bar extends over the whole width of the river.
Haydee Shoals	37½	400	50	20	
Slim Island Shoals	38½	500	65	15	
Enterprise Shoals	51	450	60	15	
Franklin Shoals	55	350	45	18	
Romeo Shoals	71	600	50	15	
Jack's Island	80	700	45	15	
Pine Prairie	85	400	55	22	
Paragythe	89	600	50	20	

CHARACTER OF BANKS AND ADJACENT LANDS.

The valley of Ouachita has two terraces or levels. The upper terrace being secure against overflow, is generally cultivated, but, on account of the sandy soil, not very productive. The lower or true bottoms, bordering the river shore, are exposed to inundation during high-water season from 3 to 15 feet, but when they can be cultivated are immensely rich, producing annually 1,800 pounds of cotton in the seed, or from 70 to 80 bushels of corn, per acre.

The vegetation in the bottom is very rich and luxuriant, and among the timber is found the red and pin-oak swamp, chestnut-oak swamp, white oak, and even the beech, all of which attain a large size. On the upland the beech flourishes, attaining remarkable dimensions. When sandy soil is prevalent it is characterized by a luxuriant growth of pine, which grows also upon the alluvial sandy deposits of the river, even to the swampy banks. On the dry uplands there are also seen white and black oak in abundance, and of fine growth. On the left bank there is not a place in the immediate neighborhood of the river secure against overflow.

On the right bank, the uplands strike the river at the following points, forming bluffs generally covered by a rich growth of pine timber. These places are:

French Port, fourteen miles below Camden, 15 feet above overflow.

Warren's Hills, twenty miles below Camden, 30 feet above overflow.

Beech Hills, twenty-five miles below Camden, 30 feet above overflow.

These hills incline toward the shore at an angle of from 25° to 35°, are remarkable for fine growth of beech trees, and recede at Newport Landing, which is built on the lower end of this portion of the line of bluffs into the interior of the country.

Miller's Bluff, thirty-four miles below Camden, 50 feet above overflow, running along the river shore 2,000 feet, and covered with pine timber.

El Dorado Landing.—The hills are half a mile back from the shore, and bear the same character as above.

Champagnole Landing, fifty miles below Camden, bluff 125 feet high.

Wilmington, sixty-four miles below Camden, 100 feet high.

Pigeon Hill, seventy-one miles below Camden, 80 feet above high-water mark. Pigeon Hill is the last place where the high uplands touch the river shore; thence to the State line low, marshy bottom lands constitute the main features of the country.

There are several landings between this last-named point and the State line for the convenience of the trade with the uplands in the interior of the country. They consist only of warehouses built on stilts, the floors of which are from 15 to 20 feet above the ground.

From the Marie Saline Landing to the State line, a distance of twenty miles, the country on either side of the river is exposed to inundation from both the high water of Ouachita River and by that of the Mississippi during the regular overflow season. At Roland's Raft, a landing five miles above the State line, the floor of the warehouse is 16 feet above the ground, and in 1867 the water stood 3 inches deep on the floor, as I was informed by the one man tending the warehouse. As the banks here are about 20 feet above low-water mark the rise would be about 36 feet.

With the exception of the few landings, there is no sign of habitation on the river banks. Dense cane-brakes, cypress swamps, old river-arms and lagoons are the principal features of the low marshy bottom.

THE OBSTRUCTIONS TO NAVIGATION,

in this section of the river, consist mainly of leaning timber and snags. The leaning timber, to the number of 32,690 trees, grows all along the shore; chiefly large willows and birch, with some sycamore and gum trees. On account of the narrowness of the river, and of its short turns, the leaning timber is a great impediment to navigation for such large boats as are used to ply during the high-water season between Camden and New Orleans. The high-water channel runs very close to the "points" in the short bends, and as the boat has to "pivot" around the point, her chimneys, rigging, and upper wood-work are always liable to come into collision with this leaning timber.

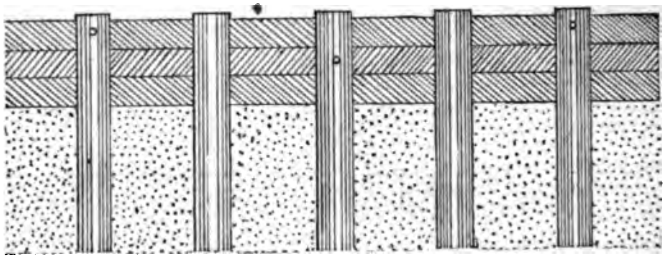
The number of snags seen at the time of the examination is 365, which number, I have no doubt, would be three times as high had the stage of the water permitted me to count all those lying in the river. Therefore, I do not consider my estimate too high when I place the number of snags at 1,000.

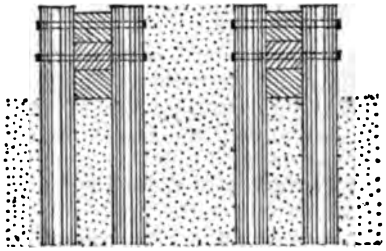
GENERAL REMARKS.

The most prominent shipping-points on the river in the State of Arkansas are Camden and Arkadelphia.

Arkadelphia commands the trade of a part of Pike, Clark, Hot Springs, and Dallas Counties, which depend altogether on the navigation of the river for shipping off the produce, and procuring supplies. As the time for navigating the river sets in, when cotton, the main staple product of the country, is getting ready for shipment, it is evi-

The following side and end elevations will illustrate:





ESTIMATE OF THE COST OF WING-DAMS.

Mouth of river to Madison.

Pile-driver, delivered	$2,500 00
2,928 piles, delivered, at $1 75	5,124 00
Driving 2,928 piles, an average of 14 feet, at 15 cents per foot	6,148 80
33,058 cubic feet hewn timber, delivered, at 18 cents per foot	5,950 44
692 bolts, with nut and washer, 4 feet 6 inches, by 1¾ inches, = 31,140 pounds, at 6¾ cents	2,101 95
600 pounds wrought-iron clamps, at 6¼ cents	37 50
621 days' labor, at $2 50	1,552 50
118 days' labor, at $4 50	531 00
3,535 cubic yards filling, at 25 cents	883 50
	24,829 69

Madison to Wittsburgh.

3,799 piles delivered, at $1 75	$6,648 25
Driving 3,799 piles, an average of 14 feet, at 15 cents per foot	7,977 90
41,444 cubic feet hewn timber, delivered, at 18 cents	7,459 92
900 bolts, with nut and washer, 4 feet 6 inches by 1¾ inches, = 40.500 pounds, at 6¾ cents	2,733 75
500 pounds wrought-iron clamps, at 6¼ cents	31 25
726 days' labor, at $2 50	1,815 00
138 days' labor, at $4 50	621 00
4,452 cubic yards filling, at 25 cents	1,113 00
	28,400 07
Total, mouth of the river to Wittsburgh	53,229 76

The removal of the snags between Wittsburgh and the mouth of the river involves all the expenditure the traffic of the entire St. Francis country will justify at this time.

At present a steamer, drawing 3 feet, runs to Wittsburgh eight months in the year. With the snags out, this time could be increased, and a boat of less draught, ample for the trade, could use the river at least ten months in every twelve.

Very respectfully, your obedient servant,

H. L. KOONS,
Assistant Civil Engineer.

Brigadier General W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

OFFICE WESTERN RIVER IMPROVEMENTS,
1122 *Pine Street, St. Louis, Missouri, October* 14, 1871.

GENERAL: I have the honor to submit my annual report upon the improvement of the St. Francis River in Arkansas.

The act of Congress approved March 3, 1871, made an appropriation for the improvement of St. Francis River in the State of Arkansas, of $10,000.

The examination made last season showed that the St. Francis is a stream of sufficient magnitude in ordinary stages of water to float one of our snag-boats, and I have recommended that the appropriation should be expended in paying the running expenses of one of our boats while engaged in removing snags and other obstructions to navigation. It will not be possible to detach a boat for this purpose, until after operations under the appropriation for the improvement of the Mississippi, Missouri, and Arkansas Rivers shall have ended.

The last-named appropriation will be exhausted by about the 1st of January next, when, if no other appropriations were available, the snag-boats would have to be laid up. Instead of doing this, the Bureau has approved my proposition to send one of them into the St. Francis, and to employ her there so long as it is practicable with the amount appropriated.

One of the snag-boats can be profitably employed at least another season, and possibly subsequently—for two months in removing obstructions from the St. Francis, and it would be much better to do so than to have the boats doing nothing, as has been the case half of each year. I therefore recommend that an appropriation should be made for that purpose, of $10,000.

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

I 9.

OFFICE WESTERN RIVER IMPROVEMENT,
St. Louis, Missouri, January 27, 1871.

GENERAL: I have the honor to forward herewith the report of the examination of Little Red River, Arkansas.

The whole extent of the navigable portion of Little Red River is less than fifty miles. The upper section of eighteen miles, extending from Searcy Landing to West Point, seems to be little more than a rivulet, excepting when the bed of the stream is filled with the back-water from White River.

At such times the removal of the overhanging trees and snags from this section, of which there are nearly 20 of each per mile, would doubtless aid the passage of the boats which attempt to reach Searcy Landing.

From West Point to the mouth of the stream, the depth of water is two feet at the lowest stage; distance, thirty miles. An average of nearly twenty snags, and more than two hundred overhanging trees, were counted on this section of the river.

The fact stated that, the commerce of this stream is sufficient to induce the comparatively large boats running on White River to navigate it whenever it is practicable, and when this is not the case, that a small steamer is kept to ply between West Point and the mouth of the river, shows the importance of the interest involved. The snag-boats now in use having been built for service on larger streams are not such as will be required on Little Red.

Having heretofore estimated for the construction of such a boat as could do the work, the cost thereof is not included in the estimate now presented.

After a boat suited for the duty is procured, the estimated cost of the required improvements are as follows:

For the removal of snags and leaning trees between Searcy Landing and West Point; two months' work of snag-boat, at $5,000 per month	$10,000
Removal of snags below West Point; four months' service of snag-boat, at $5,000 per month	20,000
Removing 6,200 trees between West Point and mouth of stream, at 50 cents each	3,100
Add 15 per cent. to meet the cost of placing snags and trees, after removal, out of the reach of high water	4,965
Total estimate	38,065

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

ST. LOUIS, MISSOURI, *January* 19, 1871.

SIR: I most respectfully submit herewith the report on the examination of Little Red River, in Arkansas, compiled from the field-notes of Captain John S. Tennyson. Little Red River is a tributary of White River, and empties into the latter, thirty miles below Augusta.

Having been ordered, at that time, to succeed Mr. A. Livermore in charge of the examination of rivers in the State of Arkansas, I proceeded to Little Red River, in order to meet Captain Tennyson on the field of operations.

By doing so, I had the opportunity to judge of the condition of the river from the mouth upwards to West Point myself, whereby I found that Captain Tennyson's notes fully coincided with my own observations. The examination of the upper part, that is from Searcy Landing to West Point, was made by Captain Tennyson alone, who had finished the same before my arrival on the river.

Searcy Landing being regarded as the head of navigation on Little Red River, the examination of this stream was commenced at that point and conducted to its mouth. The river can be divided into two sections, entirely different in their features, and they will be therefore treated separately.

The upper section reaches from Searcy Landing to West Point, eighteen miles; the lower, from that place to the mouth, thirty miles in length.

SECTION I.—*Searcy Landing to West Point.*

The bottom of the river from the upper Searcy Landing, called Merchants' Landing, is rocky throughout, and has several shoal places between these two points.

The first shoals are half a mile below Merchants' Landing, 115 feet long, and extend 211 feet from the right shore into the river. The channel is 55 feet wide and 5 inches deep at low water, with 1.1 feet fall.

The next shoal place is in front of lower Searcy Landing. These shoals are nearer to the left bank, one mile and a half long, and 200 feet wide. The width of the channel is 63 feet at the narrowest point, with 8 inches of water, and 0.8 feet fall.

Rock Island Shoals, 3 miles below Searcy Landing, are 300 feet long. The width of the channel is 61 feet; depth at low water, 9 inches; fall, 0.75 feet.

From these last shoals to Prospect Shoals, a distance of four miles and a half, there is hardly any visible current in the river. The bottom consists of loose rocks with the exception of about 500 feet, where sand is prevalent. The width of the river is in this part 275 feet on an average between banks, and has from 2 to 7 feet water in the channel.

Prospect Shoals are a half a mile above the town of Prospect Bluffs. The river-bed is covered with small rocky islands, which are from 2 to 5 feet above low water. The channel lies very nearly in the middle of the river, and is 57 feet wide, with 3 inches depth. On the right shore is a chain of loose rocks, which have been taken out of the channel and piled up in the shape of a dam. The length of these shoals is 600 feet, with 2.30 feet fall.

The left bank along this part of the river is from 25 to 35 feet high, consists of common clay and is covered with timber. There are but a few cultivated fields along this shore. The caving and washing out of the banks amounts to very little.

The right shore is high upland. The bluffs are from 50 to 60 feet high, and consist of clay, with rocks cropping out half way upon the bank. These bluffs reach their utmost height three miles below Searcy Landing, in a hill 150 feet high, which is composed of rocks clear up to the top.

From Prospect Bluff, sandy bottom is prevalent for a distance of five miles; the average width of the river is 300 feet between banks, which are low and subject to overflow; the depth of the channel is from 2 to 16 feet.

Best's Shoals, five miles below Prospect Bluffs, consist of two chains of loose rocks. On the upper chain, 130 feet long, the channel lies nearer to the left shore, is 65 feet wide, with 6 inches of water and 2.05 feet fall. The lower chain, 50 feet long, is close to the left shore, has 7 inches of water in the channel, which is 57 feet wide. Fall 0.75 feet. The loose rocks on both of these chains have been piled up in form of dams.

There is rocky bottom for the next two miles below Best's Shoals, with from 10 inches to 3 feet water in the channel.

Three miles above West Point there are piles of loose rocks scattered along the left shore and extending half way into the river.

The average width of the river from Best's Shoals to West Point is 300 feet between banks. The channel is 100 feet wide and 10 inches deep.

The right bank along this part is, on an average, 45 feet high, the left one low and subject to overflow; both are covered with heavy timber.

SECTION II.—*From West Point to the mouth.*

The river assumes more the character of a natural canal. The width is almost uniform, and varies between 250 and 300 feet. The banks are nearly of the same height, (about 25 feet,) slope at an angle of 45°, and are covered with timber from low-water edge up. The adjacent country is, during high water, subject to overflow, and there are but few spaces of cleared land in this section. The depth in the channel in this part is, at the lowest stage of water, 2 feet and over.

LOW WATER

occurs during the months of July, August, and September. The depth in the channel at low water has been described at the different localities above.

HIGH WATER

takes place first during the month of May, sometimes as early as the end of April. This is called the spring rise, and does not last very long.

The fall and winter rise from the head-waters is also of short duration. The river may rise from 15 to 20 feet within twelve hours, and fall again to the former stage within the next twelve hours.

The only rise for any length of time to depend on is the back-water from White River, when the latter is high. A rise of 15 feet in White River will make 4 feet water in Little Red River, clear through to Searcy Landing.

The highest water known was in 1867, when the high-water mark showed 39.30 feet at Searcy Landing, 32.6 feet at Prospect Bluffs, and 29.3 feet at West Point.

OBSTRUCTIONS, SNAGS, AND LEANING TIMBER.

From Searcy Landing to West Point there are 353 snags, and 289 leaning trees. The latter are seen only in two bends and close together.

From West Point to the mouth are 588 snags and 6,203 trees, 5,332 of which are less than one foot in diameter.

In regard to the improvement of the river it is evident that the scarcity of water between Searcy Landing and West Point, and the condition of the stream, will not justify any other expense than that absolutely necessary to remove the snags and leaning timber. The removal of the loose rocks from the bed of the river will be of no benefit to navigation, as there is not water enough during the dry season to give sufficient depth for the passage of boats were the obstructions removed.

The rise from the head-waters disappears as suddenly as it comes on, and whenever steamboats have ventured to go further up during a head-rise, in most cases they have been obliged to turn back before reaching Prospect Bluffs, the rise having entirely disappeared. The only rise to depend on is the back-water from White River, and whenever this takes place, there is sufficient depth of water for navigation to Searcy Landing.

The improvement in this lower part of the river will be the removing of snags and the cutting of the leaning timber on both shores.

GENERAL REMARKS.

The improvement of this stream, to the commerce of the country, will perhaps be best shown from the fact that the White River Packet Company send their boats as far into the Little Red as practicable every time they ascend White River; thus, two boats a week reach West Point from White River during about nine months in the year, and during three months these boats reach Searcy Landing; and when the water is too low to permit the large White River boats to ascend the Little Red, a small boat is kept on hand to do the business between West Point and the mouth, connecting at that place with the boats on White River.

These facts give some idea of the amount of commerce on the river; no data could be obtained as to the amount of cotton or other produce shipped.

The above is enough to show that the improvement is one of great importance to that section of country.

I am, most respectfully, colonel, your obedient servant,

JUSTIN STRASZER,
Civil Engineer.

Lieutenant Colonel W. F. RAYNOLDS,
Corps of Engineers, U. S. A., St. Louis, Missouri.

I 10.

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, January 24, 1871.

GENERAL: I have the honor to forward herewith reports of the following persons upon their examinations of White River, viz:

Alonzo Livermore, civil engineer, upon that portion of the river from Forsythe, Missouri, to Jacksonport, Arkansas.

John S. Tennyson, upon that portion of the stream between Jacksonport and Duvall's Bluff, Arkansas.

Justin Straszer, civil engineer, upon the stream below Duvall's Bluff.

The examination of White River, from the head of navigation to Duvall's Bluff, and of several other streams in Arkansas, were assigned to Alonzo Livermore, esq., who employed Captain John S. Tennyson, an old and experienced river-pilot, to aid him in his labors. While engaged on the duty, Mr. Livermore was prostrated by disease, and was unable to continue his labors below Jacksonport. In the mean time, however, Captain Tennyson had become familiar with the method of doing the work, and continued the taking of notes upon the condition of the stream, while the party was making its way to Duvall's Bluff, taking in the Little Red and Black Rivers while en route. In this way it happened that these examinations were not made by a skilled engineer, but fortunately the localities were not such as to require engineering skill for their improvement, and therefore the loss of that kind of knowledge does not prevent our forming a fair estimate of the character of the streams.

Mr. Justin Straszer was sent with the snag-boat De Russy to examine the river from the mouth to Duvall's Bluff.

As soon as I was informed by telegram of Mr. Livermore's illness, I sent Mr. Straszer to take up his work and carry on his duties to completion. This explanation is necessary to account for the shape in which the report on White River is presented.

Mr. Livermore's estimate for the improvement of White River, between Forsythe and Jacksonport, is $60,440.

His experience in river improvement would cause me to have great confidence in Mr. Livermore's estimates, if I did not fear that the state of his health occasioned his overlooking some important elements which should enter into the computation, viz: The difficulty of reaching the field in which we propose to operate, the season of the year in which the work must be carried on, and the fact that but a small amount of work, comparatively, is to be done in any one locality.

If White River above Jacksonport is improved, the work must be done in extreme low water, which only occurs in the summer or sickly season. At such times no boat can reach the locality; hence, all supplies must be wagoned to the field of operations. Besides, there will be great difficulty in procuring labor at that season, which can only be overcome by paying high wages.

These facts, taken in connection with the other, that the improvements extend over two hundred and fifty miles of river, makes me unwilling to accept these estimates without an addition of at least 50 per cent. to meet these necessary conditions of doing the work. This will make the estimate for the improvement of White River, from Forsythe to Jacksonport, in round numbers, $90,000.

The improvements proposed would enable boats drawing three feet of water to navigate this portion of the stream at any time when the river was 5 feet, or more, above its extreme low-water stage, which, in ordinary seasons, is from November until June, or six or seven months of the year. Such an improvement would be an inestimable boon to the country through which the river flows, and is all that could be effected without an unreasonable expenditure.

The examination below Jacksonport shows that boats drawing 18 inches can at all times reach that point, and 2 feet can at all times be carried as high as Augusta. As the river is at its lowest stage during but few months in the year, it is not considered advisable to attempt to deepen this portion of the stream, the removal of the snags being all that is necessary.

Captain Tennyson has counted over eight hundred snags and more than two thousand leaning trees which are in the way. To remove these will require a snag-boat of different construction from those we now have, one drawing less water than the large boats and more easily handled than the Thayer, and which can work closer to the shore than either of them. Such a boat would be of great use in the improvement of all the western rivers. An estimate for the construction of two such boats was submitted with my report of October 10, 1870, amounting to $200,000.

With a boat fitted for the duty, the snags and trees could be removed in six months' time at a cost of $30,000.

The wrecks in this portion of the river are not reported as special obstructions to navigation, hence no estimate is submitted for their removal.

Below Duvall's Bluff the river is at all times navigable for boats drawing 3½ feet of water. The snag-boat R. E. De Russy operated during a portion of the past summer in this section of the river, and cleaned the channel of the most dangerous snags, but owing to her size and construction, she was unable to remove many dangerous snags close to shore. Some three hundred such yet remain, which should be removed. This could be done *after a suitable boat was constructed*, in about two months, at a cost of $10,000.

The greatest obstructions to navigation below Duvall's Bluff are wrecks, eight of which are reported as being in the channel. I have had no experience in this kind of operations, nor any published data upon which to base an estimate, but after consulting with Captain James B. Eads, who has been extensively engaged in such business, I venture to estimate the cost of removing them at $5,000 each, or for the eight, $40,000.

RECAPITULATION OF THE ESTIMATED COST OF THE IMPROVEMENT OF WHITE RIVER.

For the improvement of the river from Forsythe, Missouri, to Jacksonport, Arkansas, to enable boats drawing 3 feet of water to navigate the stream during six months in the year	$90,000
For the removal of snags and leaning trees between Jacksonport and Duvall's Bluff	30,000
For the removal of snags and leaning trees between Duvall's Bluff and the mouth	10,000
For the removal of wrecks in the channel below Duvall's Bluff	40,000
Total	170,000

All of which is respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

MEMPHIS, TENNESSEE, *November* 15, 1870.

SIR: I have the honor as well as the privilege of reporting to you the following facts, and my opinions which have been elucidated from the examination I have made (in conjunction with my assistant, Captain J. S. Tennyson) of *White River*, commencing at Forsythe, in Missouri, and ending at Duvall's Bluff, in Arkansas, a distance of four hundred and forty miles. *Black River* was also examined by Captain Tennyson (while I was sick at Jacksonport) from its mouth to Pocahontas, a distance of one hundred and fifty-one miles, and is situated altogether in the State of Arkansas. This examination of those rivers was made under instructions from you dated August 25, 1870.

I am pained to inform you that my individual attention was diverted from a portion of this examination by a severe attack of a sore eye, which rendered me almost blind for a time, besides throwing me into a violent fever, caused, as I think, from excessive pain. I am, however, glad to inform you that I do not consider my personal service in this respect a material loss.

There were no important engineering points to be examined while Captain Tennyson was conducting the examinations. Besides, I was with him upon the whole of White River, and gave him ample directions, both for this and Black River. I feel, therefore, confident that all has been faithfully performed. Had my eyes and general health been good, I should have examined his notes before leaving the river, and thereby have been enabled to report in full these two rivers, as I would wish.

Little Red River was also examined by Captain Tennyson under instructions from me, but not until I left Duvall's Bluff and came to this place. Unfortunately, Captain Tennyson was taken sick soon after examining Little Red, and I have not had the privilege of getting any of the notes or opinions of the captain, except so far as they were given me verbally before I left. I judge, however, these will be reported upon by my successor, and no injury will result to the public service. If Little Red is included, the examination under my charge embraced a distance of about six hundred and fifty miles, averaging about thirteen miles per working day. Considering the difficulties we encountered, especially for the first one hundred miles, where, from extreme low water, our boat had to be dragged over very many of the shoals by hand, this average is therefore a large one.

But much of our success in getting along so well is due to the skill and energy displayed by Captain Tennyson. I would, therefore, hereby acknowledge my indebtedness to him for his untiring zeal, his uniform kindness to me individually, always showing a wish to forward my desires in relation to the work, and his kind attentions to me while I was disabled.

While making these preliminary remarks, permit me to say in regard to myself, that after arriving at Duvall's Bluff I became fully convinced that my diseased eye would not allow me to go on any farther, at least this fall, with the charge you had assigned me upon other rivers in Arkansas.

I therefore on the 11th of October signified my intention of resigning at an early day. This has been a sore grief to me, but as necessity knows no law I was compelled to submit. With this I return you my heartfelt thanks for your uniform kindness while I have been employed under your directions; and now, after signing this report, resign in full the position you have given me.

REPORT RELATIVE TO OBSTRUCTIONS REQUIRING ENGINEERING TALENT TO IMPROVE.

The miles here counted are estimated only, and commence at Forsythe. In giving the name of shoals I found that the people along the river differ, often materially. In giving the name, therefore, I may not always be understood, but by referring to the mile, and the points contiguous, I judge no misunderstanding will take place. The word *shoal*, as used in this report, includes not only shallow water, but a fall of several inches to several feet.

Elbow Shoals will be found on mile 53. These shoals are well known, and require no further description of their location. The fall immediately at the elbow is 2.28 feet; further down—say, eight or ten hundred feet—there is an additional fall of 1.76 feet—altogether equaling 4.04 feet as the whole fall of Elbow Shoals. I made a survey and took a level of these shoals, and herewith present a sketch of this obstruction.

The points or lines marked No. 1 and No. 2 are the remains of old dams erected some years ago by the State of Arkansas, but are now nearly washed away. From appearances, these works were built with open cribs, and were entirely too low to overcome the fall before the water passed over them. A strong dam should be built at least 10 feet high, covered on breast and top, so that no opening for stone to escape can be left exceeding 6 inches in width.

The island at the head is composed principally of large stones, and by excavating from C to H, will give sufficient stone to fill the cribs, besides strengthening the work at both ends of the dam.

The timbers used in the dam should be generally of good white-oak. Much of it will be exposed for a part of the year.

15,000 feet of foot-thick crib and other timber, at 16 cents	$2,400 00
4,000 pounds iron bolts, at 12 cents	480 00
5,000 cubic yards loose stone and gravel removed from the channel and carried into cribs and embankments, at 60 cents	3,000 00
Add for contingencies and superintendence	1,200 00
Total	7,080 00

The dam will be about 300 feet long, and if properly built, will be the means of keeping open a new channel, which will be entirely safe for navigation.

BULL SHOALS.

Shoal on mile 78 has an estimated fall of 3¼ feet in a distance of one-fourth of a mile. This shoal is called *Bull Shoal*, and will require dredging or some other means of opening up the channel. The cost of work on this shoal may be set down at $700.

Mile 85 ends at mouth of Little North Fork, and has an estimated fall upon Shoal 91 of 2 feet. This shoal will have considerable loose rock and gravel to remove, the estimate for which I set down at $660.

M'GAR'S SHOALS.

On mile 86, located immediately below below Little North Fork of White River, river spreads out quite wide over a solid rock bottom with hardly a perceptible channel. A channel must be opened by excavating solid rock, more or less, over a distance of 800 or 900 feet. Channel should be about 100 feet wide. The fall is estimated here to be 2½ feet. The work should be done in low water. A gravel and earth coffer-dam should be built on the two sides and across the upper end of the proposed channel. The water will then draw off from the work which requires to be excavated. The estimate for this work is as follows:

2,500 cubic yards rock, at $2 50	$6,250 00
Contingencies	1,250 00
Total	7,500 00

SHOAL ON MILE 98.

Estimated fall of 2½ feet. This shoal is on solid rock, with high ridges or points, which must be removed for 80 or 100 feet in width. The work will be very similar to that described on McGar's Shoals. The quantity of rock to be excavated will not be as large. The estimate may be set down as follows:

1,000 cubic yards rock, at $3	$3,000 00
Contingencies	800 00
Total	3,800 00

MILE 113.

Red Bend Shoal on the lower part of this mile, fall of which is estimated at 2½ feet. In the channel some loose rock to be removed, and a wing-dam on the right from island to the shore. The cost upon this mile may be estimated at $2,000.

BUFFALO SHOALS ON MILES 122 AND 123.

These shoals are two miles long, on a solid rock bottom. Although the river is reasonably straight, the channel changes its course by taking sometimes the left side, sometimes the middle, at other times near the right shore. The changes, however, are gradual, and do not much injure the navigation. The wing-dams will therefore have to be constructed to suit this channel. If properly located and constructed they will form intermediate basins or pools, which will operate to deaden the current in the channel and greatly help navigation. The entire fall of these shoals I estimate at 10 feet. There will be a considerable amount of excavation necessary in the channel, and may be done much in the manner recommended upon McGar's Shoals. The excavation should, however, be carried into the wing-dams.

These shoals, as will be seen by the following estimate, are the most expensive, and perhaps the improvement as important as any upon the river:

3,000 cubic yards excavation, at $3	$9,000 00
2,500 cubic yards into wing-dams, at $1	2,500 00
Add for contingencies	2,500 00
Total	14,000 00

RAPIDES SHOAL ON MILE 138.

The bottom here is solid rock, and there is considerable loose rock to remove. Fall here, about 3 feet.

Estimate.

200 cubic yards solid rock excavation, at $3	$600 00
200 cubic yards loose rock excavation, at $1	200 00
Contingencies	200 00
Total	1,000 00

MILE 206—CORN-WALL SHOAL.

Wing-dam necessary in this shoal, the fall of which is estimated at 3 feet. Low islands divide the water into numerous channels, and these are very crooked. Wing-dams here and other work may be estimated at $3,000.

MILE 209, AT BATESVILLE—BATESVILLE SHOAL.

This shoal is estimated to have a fall of 4 feet. The channel is very crooked, and must be improved by dredging or otherwise. Estimated cost here, $2,000.

Mile 210 also has a very crooked channel, but the fall only estimated at .50. A part of Batesville Shoal on this mile. The estimate for dredging may be put, wing-dam also, at $2,000.

Mile 211 will also require some dredging work, which may be estimated at $1,000.

Mile 214 requires a wing-dam on Patty Breath Shoal, fall of which is estimated at 3 feet. This wing-dam and some dredging of channel will cost, probably, $1,500.

MILE 251—MUSIC SHOAL.

Estimated fall of 2¼ feet; very crooked. This shoal is very bad, and will require considerable work with dredge, and at least one wing-dam. The work on this shoal may be estimated at $4,000.

RECAPITULATION OF COST OF OBSTRUCTIONS REQUIRING ENGINEERING SKILL.

Elbow Shoals, mile 53	$7,080 00	
Bull Shoals, mile 78	700 00	
Shoals, mile 85	660 00	
McGar's Shoals, mile 86	7,500 00	
Shoals, mile 98	3,800 00	
Section 1, 100 miles		$19,740 00
Red Bend Shoals, mile 113	2,000 00	
Buffalo Shoals, mile 122 and 123	14,000 00	
Rapides Shoals, mile 138	1,000	
Section 2, 200 miles		17,000 00
Corn-Wall Shoals, mile 206	3,000 00	
Batesville Shoals, mile 209 and 210	4,000 00	
Shoals, mile 211	1,000 00	
Patty Breath Shoals, mile 214	1,500 00	
Music Shoals, mile 251	4,000 00	
Section 3, 300 miles		13,500 00
Grand total		50,240 00

No further obstructions of the above character exist on White River below Jacksonport, on Black River from mouth to Pocahontas, or Little Red for sixty miles above the mouth.

The following is the estimated cost of minor obstructions, such as removing snags, logs, loose rock, and leaning trees from the channel of White River from Forsythe in Missouri to Jacksonport in Arkansas, a distance of two hundred and fifty-four miles. The like obstructions on the balance of White River from Jacksonport to Duvall's Bluff, of Black River, from mouth to Pocahontas, and of Little Red from mouth sixty miles, were examined by my assistant. To his report I would therefore respectfully refer for the information not here reported.

SECTION 1—100 MILES.

This section was examined under favorable circumstances, the river being exceedingly low; lower, it was said, than ever known before. The section commences at Forsythe and terminates with the one hundred miles.

It may be here proper to remark that I had the river measured for what I considered its average width of channel, and found it to be 400 feet. I also measured the flow of water at mile 67 and found it 264 cubic feet discharged per second. The average height of the bottom land I found by the level to be about 23 feet, and the highest water-mark shown me as known, was 28 feet. I think that this may be considered a fair average for the whole distance to Jacksonport. I would here state, however, that the width of the river below this section will average probably 500 feet.

The character of the country for near two hundred miles is quite rough. The hills and rock bluffs are very high and precipitous. The bottom lands are narrow, generally on one side of the river at a time, and seldom over one-half mile in width.

Lead and other ores are said to exist in such quantities as will justify working, near this river. Most of the country may be said to be in its primitive condition. Population quite sparse. The land, much of it, said to be Government domain. The improvement of the river, as here proposed, would add largely to the inducement of settlement.

The country below the first two hundred miles presents fewer hills, much of the way bottom lands on both sides, and far wider than the upper part of the river, and often much lower, being subject to more frequent overflow.

I may say, once for all, that the river in general, for two hundred and fifty-four miles, is shallow when the water is low, the pools varying from 1 to 5 feet deep, while the shoals, which were numerous in the extreme low water of this season, hardly in any case had a sufficiency for floating our boat, which drew only 6 inches when the party of four persons were all aboard.

The banks of White River in general are quite permanent as far as Jacksonport, the undermining of the banks by water seldom seen.

The estimate made here was set down mile by mile as we descended the stream, and after making this estimate, I added full 20 per cent. to cover all contingencies. At this rate—

Section No. 1, 100 miles, will cost	$3,300
Section No. 2, 100 miles, will cost	4,200
Section No. 3, 54 miles, will cost	2,700

RECAPITULATION OF COST OF SECTIONS, INCLUDING OBSTRUCTIONS REQUIRING ENGINEERING SKILL.

Section No. 1, 100 miles	$23,040
Section No. 2, 100 miles	21,200
Section No. 3, 54 miles	16,200
Grand total	60,440

I have taken notes of estimated fall at each shoal, adding to each mile 6 inches. The following is the results of this estimate:

Section 1, 100 miles	152.30	feet.
Section 2, 100 miles	143.35	"
Section 3, 54 miles	75.55	"
Total	371.20	"

I think it probable that this estimate will be found large, if ever the correct fall is ascertained. The average is here nearly 1½ feet per mile.

I would further add that after descending over the 1st section the river rose about 4 feet. I do not consider, therefore, the estimate of cost or fall as satisfactory for the remaining distance as over this section. The rise, however, greatly hastened our work, and upon the whole, perhaps, all was for the best, the character of the river being well known by the examination made before the rise.

I remain, very truly, your obedient servant,

ALONZO LIVERMORE,
Civil Engineer.

General W. F. RAYNOLDS,
Lieutenant Colonel Corps of Engineers, U. S. A.

ST. LOUIS, MISSOURI, *January* 11, 1871.

SIR: In compliance with your orders I proceeded to the mouth of White River and made an examination of that river from the mouth upwards to Duvall's Bluff, where I met Mr. A. Livermore, civil engineer, in charge of the party coming down from the head-waters of that stream. Captain John S. Tennyson, pilot, employed by Mr. Livermore, had, by that time, finished the examination of White River from Jacksonport to Duvall's Bluff under the instructions and supervision of Mr. Livermore, who on account of sickness was unable to complete his report and examination of that section of the river. Having been assigned by subsequent orders to succeed Mr. Livermore in charge of the party, it devolved upon me to prepare from the field-notes the report on the condition of White River between Jacksonport and Duvall's Bluff.

It is proper here to give Captain John S. Tennyson full credit for the manner in which he has performed this work. Having had the opportunity of taking notes on the condition of the river from Augusta to Duvall's Bluff, while passing over that section, I am bound to say, that his notes were taken with the greatest accuracy, and that he has made true observations in regard to the nature and condition of the river.

The following report will be thus divided into two chapters, the first of which will treat the section from Jacksonport to Duvall's Bluff, compiled from Captain Tennyson's field notes; the second comprises the result of my own observations on the lower river from Duvall's Bluff to the mouth.

SECTION I.—*Jacksonport to Duvall's Bluff, distance* 189 *miles.*

The width of the river from Jacksonport to Augusta averages 500 feet between banks, and from the latter place to Duvall's Bluff 400 feet. The width of the channel on the bars and at the narrowest places is between 70 and 80 feet, while in the bends and pools it varies from 150 to 200 feet.

The depth of the channel at low water is from 12 to 18 feet in the pools, and from 22 to 30 inches on the shallowest places and bars. The following are the principal bars:

Lone Willow Bar, situated twelve miles below Jacksonport, is three-quarters of a mile in length, and divides the river into two channels; the main channel is near the right shore and 150 feet wide. At the lowest stage of water ever known, the depth in the channel was 23 inches; fall, 1 foot.

Reed's Bar, fifteen miles below Jacksonport; three-fourths of a mile long; extends from the right shore into the river, leaving only a channel width of 75 feet, with 21 inches depth at low water; fall, 1.1 feet.

Little Island Bar, twenty-eight miles below Jacksonport, is a blind gravel bar (or a bar not made apparent by the ripple) one mile long; width of channel, 75 feet; depth in the channel at low water, 21 inches; fall, 1.2 feet.

Grand Glaize Bar, tow-head, opposite the town of Grand Glaize, half a mile long and 150 feet wide. The channel follows the left shore, is 75 feet wide, with 23 inches depth at low water. Along the left shore are leaning trees which obstruct navigation to a great extent, as, in low water, boats have to pass very close to the shore. Between the tow-head and the right shore is a gravel bar with 12 inches at low water. Dredging would be of great advantage on this bar; fall, 0.75 feet.

Dudley's Dread, fifty-eight miles below Jacksonport; a dry gravel bar in the middle of the river, and half a mile long. The channel, after turning a very short point, follows the left shore, is 75 feet wide, and, at low water, 23 inches deep. Being a short bend, the leaning heavy timber and a number of snags make it very dangerous for boats to pass in low water; fall 1.1 feet.

The next two shoal places are at a distance of three and five miles below Augusta; they have no special names. The first one is a blind gravel bar, crossing the river from the left to the right shore, and half a mile long. The depth in the channel, which is 75 feet wide, at the lowest stage of water known is 23 inches. The second shoal place is a blind bar, extending from the left shore into the river. The channel is 75 feet wide, and has 26 inches depth at low water.

The bottom of the river on the shoals consists of gravel, while in the pools it is composed mostly of clay and mud.

CHARACTER OF THE BANKS, BOTTOM, AND HIGH-LANDS.

Between Jacksonport and Augusta the banks consist of a hard white or blue clay, and are not subject to caving, but gradally wear away at the rate of from 4 to 5 inches per year. From Augusta to Duvall's Bluff the banks are even more firm than those between the above-named places.

The whole country adjoining the river, except a few places where the high-lands strike the shore, is overflowed from 3 to 10 feet during the high-water season. Although there are but two places between Jacksonport and Augusta which are secure against overflow, viz, Grand Glaize and Petit Glaize, yet nearly every bend for fifty miles below Jacksonport is cultivated; thence thirty miles to Augusta there is little sign of cultivation; dense cane-brakes and swampy lands cover the bottom.

From Augusta to Duvall's Bluff the high-lands touch the left bank at Augusta, at Peach Orchard Bluffs, fifty miles below Augusta, and at "Surrounded Hill," four miles above Duvall's Bluff. On the right shore the high-lands strike the river first at Negro Hill, forty miles below Augusta or ten miles below the mouth of Little Red River, and extend toward Duvall's Bluff, being more or less distant from the river-bank, which they touch at the following places: Bayou Des Arc, seventy-four miles; City Des Arc, seventy-six miles; Cogley's Mill, eighty-six miles; Weak's Landing, ninety-three miles; Wattensaw, ninety-five miles; Lake Bluff, ninety-eight miles; and Buena Vista, one hundred and four miles below Augusta.

The bottom-lands on both sides of the river are subject to overflow in the same degree as above Augusta, and there is but little sign of cultivation in the bottom, which is covered by heavy timber and dense cane-brakes, intersected by bayous and swamps.

The high-water mark at Jacksonport in 1867 was 29 feet 3 inches above low water, overflowing the town 2 feet, and the adjacent country from 3 to 10 feet. The regular overflow occurs early in the spring, but is of short duration, not exceeding three weeks.

OTHER OBSTRUCTIONS TO NAVIGATION.

Besides the shoals and bars, leaning timber and snags impede the navigation. The number of leaning trees between Jacksonport and Augusta amounts to 702, the greatest part of which measure more than 2 feet in diameter. There are also 347 snags, 132 of which are shore-snags. From Augusta to Duvall's Bluff there are 1,313 leaning trees and 492 snags.

WRECKS.

The following steamboat wrecks lie in the river: One wreck, name not known, thirty-four miles below Jacksonport; wreck of steamer Cambridge, fifty-six miles below Jacksonport; wreck of steamer Clairmont, sixty-six miles below Jacksonport; wreck of stern-wheel boat, seventy-three miles below Jacksonport; wreck of stern-wheel boat, seventy-four miles below Jacksonport; wreck of steamer Acacia Cottage, three miles below the mouth of Little Red River, in the middle of the river, but there is room enough on both sides for boats to pass. These wrecks are not special obstructions to navigation.

GENERAL REMARKS.

To improve the navigation of the river in this section all the leaning timber should be cut, including, also, dead trees close to the shore. The leaning timber at the heads of the bends are mostly large willows, some sycamore and ash. At these points even the smallest trees should be removed, as the channel lies very near to the shore in those bends. There is more damage done by the trees and shore-snags in the heads of the bends than by those out in the open river; they cause a great deal of delay to boats, especially in going down stream, and are very dangerous.

This section of the river, when clear of the obstructions as noted, will not require any expenditure for a number of years. There is always water enough in the river to allow boats drawing 2 feet of water to go any season of the year to Augusta, and for boats drawing 18 inches to run between Augusta and Jacksonport.

The current between Jacksonport and Augusta will average three miles per hour, and from Augusta to Duvall's Bluff two and one-half miles per hour.

SECTION II.—*Duvall's Bluff to the mouth, distance* 150 *miles.*

The river traverses this section in a very winding and crooked course, which is most remarkable from Duvall's Bluff to Clarendon, a distance forty-one miles.

The average width between these two points is 350 feet between banks; the width of the channel is from 75 to 125 feet, and 5 feet of water on the shallowest places.

From Clarendon to St. Charles, forty-seven miles, there are longer stretches in the river, but wherever the river changes its course the turns are short and always have a small bar around the convex part of the bend, commonly called the "Point." The average width between banks is 500 feet; the width of the channel at low water varies from 100 to 200 feet. The shoalest places in this section are—

Four Mile Bar, fifteen miles below Clarendon; channel width 80 feet, and 4½ feet depth in low water; and

The crossing of the channel, two miles below Mount Adams, and half a mile long. At low water the channel is 90 feet wide and 4½ feet deep.

From St. Charles to the mouth of Bayou La Gruez, forty-two miles, the river assumes again a very winding course, and has an average width of 350 feet between banks, but being narrower, the depth in the channel, which is from 100 to 150 feet wide, is such that boats have no difficulty to run during low-water season.

The only shoal place in this part is *Little Island Bar*, a blind gravel bar at the head of Little Island, twenty-one miles below St. Charles, and half a mile long. At low water the width of the channel is 90 feet, with 3½ feet water over the bar.

From the mouth of the Bayou La Gruez to the confluence of White and Mississippi Rivers, a distance of twenty-one miles, the course of the river is straighter, having but a few gradual bends. It is from 600 to 800 feet wide; the channel-width averages 200 feet, with from 10 to 18 feet depth. The shoalest water is on the *crossing the channel*, two miles above the confluence, having at low water 3½ feet depth by a channel-width of 90 feet.

During high-water season there is sufficient depth for the navigation of the river with the largest boats built for the White River trade, carrying about 750 tons.

HIGH AND LOW WATER.

The lowest stage of water occurs during the months of July, August, and September.

The first head-rise in the river takes place during the month of May, amounting from 3 to 4 feet, but does not last over three weeks.

The next rise occurs in the early part of October, lasting about three weeks, after which the river generally falls from 2 to 3 feet.

The third rise, called the "fall or big rise," takes place in November. From this time to the spring rise, or the overflow in March, there remains generally a fair stage of water during the winter season. Exceptionally, there was low water during the month of December, 1868. The highest water known was in 1844 and 1867, when it rose in the former year 27 feet, and in the latter 29½ feet, above low-water mark at St. Charles.

From Indian Bay, seven miles below St. Charles, to the mouth, the stage of water is also greatly influenced by that of the Mississippi River. At the time of the Mississippi overflow, the whole country adjoining both shores of White River is under water from 5 to 10 feet.

CHARACTER OF BANKS, BOTTOM-LANDS, HIGH-LANDS.

The banks are very firm, consist of red and blue clay, and not subject to caving, but are washed off by rain and steamboat waves, amounting to about from 6 to 8 inches per year. Caving of the banks only occurs below the mouth of the Arkansas River cut-off.

The country along the left shore of the river is low and subject to overflow from 3 to 10 feet. The only, yet an old settlement on the left bank, is Clarendon, part of which is also under water during the overflow season. This place, and two farms a few miles below, are the only signs of habitation along the left shore. High timber, dense cane-brakes, old river-beds forming lakes and swamps, constitutes the features of the country.

On the right bank the uplands, consisting chiefly of high prairie-lands, are nearer to the river, forming generally a steep bluff toward the bottom-lands and at such places where they touch the river immediately. It is at these points where the settlements are situated, consisting generally only in a few houses and a warehouse for the convenience of the trade with the interior of the country. These points are: Arcapola, two miles below Duvall's Bluff; Aberdeen, ten miles below Clarendon; Cass Coe, twenty miles below Clarendon; Mount Adams, twenty-five miles below Clarendon; Crockett's Bluff, thirty-four miles below Clarendon; St. Charles, forty-two miles below Clarendon. The height of the bluffs on which these settlements are built varies from 15 to 30 feet above high-water mark.

The bottom along the right shore from Duvall's Bluff to St. Charles is from one to three miles wide, and bears the same character as that on the left shore. Below St. Charles the high-lands recede entirely from the river, and there is no sign of cultivation from St. Charles to the mouth.

OBSTRUCTIONS TO NAVIGATION, LEANING TIMBER, SNAGS, AND WRECKS.

The obstructions in this section of the river consist, in part, of overhanging trees, but chiefly in snags and wrecks. There are altogether not more than 200 leaning trees, which, being mostly in short bends, are apt to damage the rigging and chimneys of boats.

The snags immediately in the channel of the river have been removed by the United States snag-boat R. E. De Russy during the present season. There are still about 300 snags which ought to be taken out, mainly such as lie very close to the shore in the bends; it was impossible for the above-named boat to work with advantage in this river, especially at such places where the position of the snags required her to work close to the shore. To perform the work in this river with success a smaller boat, drawing less water, but having, nevertheless, powerful machinery, would be required.

The worst obstruction to navigation are the wrecks, some of which lie directly in the channel, and impede navigation to a great extent. The following will exhibit the statistics in regard to these wrecks:

Wreck of Sam Hale, a quarter of a mile below Duvall's Bluff, lying in the middle of the channel, and is dangerous at low water.

Wreck of stern-wheel boat Little Rock, five miles above Clarendon, lies in the middle of the channel; at low water part of machinery visible. As boats have to pass within a few feet of the wreck at low water, she is considered one of the most dangerous obstructions to navigation; is owned by an insurance company, the name of which I was not able to learn.

United States gun-boat Queen City, sunk, 1864, by the confederate forces, one mile below Clarendon; not considered in the way of boats.

Wreck of the "Entrechange," a half mile above Cass Coe, close to the channel and dangerous at low water.

Wrecks of Kate Bruner, Mary Patterson, Eliza J., and a gun-boat.—These four wrecks are 400 feet below the landing at St. Charles, and were sunk during the late war. Three of them lie in one heap about 100 feet from the right shore; the fourth is between them and the left shore, under water, and in the middle of the channel. At low water there is hardly room enough to pass, either between the wrecks or along the left shore.

Wreck of the steamer Sangamon, at the head of Big Island, three and a half miles below St. Charles, almost entirely rotten, but the stump on which she sunk is still in the river, and being a hidden obstruction, very much dreaded by pilots.

Wrecks of a wood-barge and of steamer Diurnal, below the wreck of the Sangamon; both lying on the sand-bar and not considered dangerous.

Wreck of a wood-barge, a half mile above the mouth of the river, lying close to the bank, and is not a dangerous obstruction.

I am, colonel, very respectfully, your obedient servant,

JUSTIN STRASZER,
Civil Engineer.

Lieutenant Colonel W. F. RAYNOLDS,
Corps of Engineers, U. S. A., St. Louis, Missouri.

I 11.

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, Missouri, January 24, 1871.

GENERAL: I have the honor to forward herewith a report upon the examination of Black River, Arkansas, made by Captain J. S. Tennyson. In my letter of January 24, forwarding report on White River, the circumstances under which this examination was made are explained, and need not be repeated here.

The table of shoals given in the report shows that the greatest obstruction of that kind in the stream has 2 feet of water on it at the lowest stage; hence, Black River, so far as regards shoals, is a better stream for navigation than White River, to which it is tributary, and, therefore, the shoals need no improvement.

The large number of snags and leaning trees which now obstruct the navigation of this stream, and the two wrecks lying in it, should be removed, as the extensive and fertile country upon its banks depends solely on the river for getting its produce to market.

Again, I have to call attention to the necessity of boats of different construction from any we now have for doing this work. After such a boat *shall have been furnished*, the estimate for improving the navigation of Black River is as follows:

Cutting and removing 11,936 trees on the banks, at 50 cents each	$5,968
Removing 2,019 snags, eight months' work for snag-boat, at $5,000 per month	40,000
Removing two wrecks, at $2,500 each	5,000
Total estimate	50,968

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

St. Louis, Missouri, January 17, 1871.

SIR: I most respectfully submit herewith the report on the condition of Black River, in the State of Arkansas, compiled from field-notes of Captain John S. Tennyson, who made the examination of that stream under instructions and supervision of Mr. A. Livermore, civil engineer, my predecessor in charge of river examinations.

Black River is a tributary of White River, heads in the southern part of Missouri, and empties into White River half a mile above Jacksonport.

The examination of the river was commenced at Pocahontas, the head of steamboat navigation, and conducted from that place to the confluence with White River, a distance of one hundred and fifty miles.

This work was done under the most favorable circumstances, the river having been at the lowest stage of water known for a number of years, according to information from people inhabiting that section of country.

The river traverses, in a winding course, low bottom-lands, which are subject to overflow during high-water season. It has very short turns and bends, and forms a succession of pools and shoals.

The average width between banks is 275 feet. The width of the channel in the pools is 75 feet at low water, with from 6 to 8 feet depth, while on the bars and shoals the narrowest channel is 33 feet wide and 27 inches deep.

The principal shoals and bars are located by distance from Pocahontas. Their location and condition are exhibited in the following table:

Number.	Name.	Distance from Pocahontas.	Length of shoals.	Channel at low water.		Fall.	Remarks.
				Width.	Depth.		
		Miles.	*Feet.*	*Feet.*	*In.*	*Feet.*	
1	Shoals of Pocahontas	......	800	40	28	1.10	Rocky bottom.
2	No name	2	400	40	30	0.75	Gravel bottom.
3	.....do	18	500	40	28	0.50	Do.
4	.....do	20	350	45	30	0.75	Two large loose rocks in the channel.
5	.....do	28	600	40	24	0.50	Gravel bottom.
6	.....do	30	500	45	28	1.25	Do.
7	.....do	32	300	35	28	1.25	Do.
8	Spring River Shoals	33	700	40	28	1.50	Do.
9	Devil's Race Paths	34	850	35	27	1.00	Do.
10	Lower Devil's Race Paths	34½	700	35	27	1.25	Do.
11	Eagle's Nest Shoals	36	350	33	28	1.50	Do.
12	No name	38	450	35	27	1.00	Do.
13	Powhatan Shoals	40	900	35	27	1.75	Do.
14	No name	42	400	35	27	0.75	Do.
15	.....do	63	350	40	27	0.50	Do.
16	.....do	65	500	40	30	0.50	Logs on the bottom.
17	Tim's Victory Shoals	70	350	33	30	1.00	Gravel bottom.
18	Berkley's Shoals	140	350	40	29	0.50	Do.
19	Little Paroquitt	142	500	40	30	1.25	Gravel and logs.
20	Paroquitt	144	450	45	30	0.75	Do.
21	No name	147	350	40	30	0.50	Gravel bottom.

Total fall on the shoals 19.85 feet.

The fall in the pools is about 2 inches per mile, which, added to that on the shoals, will give 35 feet fall for the river from Pocahontas to the mouth. The current in the pools is very slight, and averages about one mile and a half per hour.

CHARACTER OF THE BANKS—BOTTOMS AND HIGH-LANDS.

The banks consist of clay, are firm and not subject to caving, and, on an average, 20 feet above low-water mark. During the high-water season they are generally overflowed from 6 to 10 feet. On the left shore there are three places which are generally above overflow, but in extreme high water the ground is covered by water from 4 to 6 inches, which, however, is of short duration. These places are Clover Bend, sixty miles; Jefferson City, one hundred and ten miles; and Elgin, one hundred and twenty-five miles below Pocahontas. On the right shore the high-lands incline in a gentle slope toward the river, and touch the same at the following points:

Pocahontas, half a mile distant from the river, and 125 feet above low-water mark.

At Davisonville, twenty-five miles below Pocahontas, the hilly uplands form a rocky bluff, consisting of limestone, 2,700 feet long, and 50 feet above high-water mark.

Powhatan, forty miles below Pocahontas. The business portion of the town lies at the foot of the hills, and is, during the overflow season, 6 feet under water. The hills are about 150 feet high.

Strawberry Landing, ninety-five miles below Pocahontas, on a clay bluff, 20 feet above high-water mark.

Little Paroquitt, one hundred and forty miles, and Paroquitt, one hundred and forty-three miles below Pocahontas, are built on the declivity of gently sloping hills, 40 feet above high-water mark.

The country in the immediate neighborhood of the river shores being subject to overflow is but little cultivated, but a few miles distant from the river the ground elevated above the overflow is very fertile, and the greatest portion of it under cultivation.

OBSTRUCTIONS, LEANING TIMBER, SNAGS, AND WRECKS.

Leaning timber is very abundant, amounting to the number of 11,936 trees, 8,241 of which are less than one foot in diameter; 2,989 from 1 to 3 feet; and 706 over 3 feet in diameter.

The number of snags lying in the river is 2,019, of which 1,189 are classed as shore snags, that is, such as lie close to the shore which is next to the channel.

There are also two steamboat wrecks in this river, which, being directly in the channel, are considered very dangerous obstructions. They are the wrecks of the W. F. Brooks, opposite Jefferson City, lying across the channel; there is hardly room enough for boats to pass. Wreck of the Fairy Queen, in Fairy Queen Bend, one hundred and eighteen miles below Pocahontas, lying in the middle of the channel.

Owing to the narrow channel, and general character of the river, it will be necessary in improving it to pursue a method differing from that pursued in the improvement of the Mississippi River. Nearly all the leaning timber after being cut, and all the snags and stumps, will have to be deposited, either on the shore, or on the shore bars below the points. This will require a snag-boat entirely differing in construction of hull and machinery from those now used on the western rivers.

GENERAL REMARKS.

The improvement of Black River is of immense importance to the country which is traversed by that stream. The interior is very fertile and mostly cultivated in cotton. The population of this district depends entirely on the navigation of the river, both for shipping off the produce and for procuring the supplies for the necessities of life. The dangers of navigation, caused by the present condition of the river, allow but very small boats to run, and that only in daylight, it being too hazardous to run during the night, especially in low water.

When clear of obstructions Black River will be a better stream for navigation, than White River is from Augusta to Jacksonport, and it will admit, during high-water season, the large boats that are running in Lower White River, whenever the stage of the water in the latter is such, that they can reach Jacksonport. It will, once cleaned out thoroughly, require no more expenditures for a number of years, and remain, having no caving banks, a natural canal.

I am, most respectfully, colonel, your obedient servant,

JUSTIN STRASZER,
Civil Engineer.

Lieutenant Colonel W. F. RAYNOLDS,
Corps of Engineers, U. S. A., St. Louis, Missouri.

OFFICE WESTERN RIVER IMPROVEMENTS,
1122 *Pine street, St. Louis, Missouri, October* 7, 1871.

GENERAL: I have the honor to submit my annual report of operations upon the White, Black, and Little Red Rivers, in Arkansas.

Under the date of July 23, 1870, the "examination or survey" of these streams were placed under my charge. Separate reports were made upon each stream. The report of a reconnaissance of White River, from Forsythe, Missouri, to its mouth, with approximate estimates for its improvement, amounting to $170,000, was forwarded to the Bureau January 21, 1871.

On the same day I also forwarded a report of a reconnaissance of Black River, from Pocahontas to its mouth, with approximate estimates for its improvement, amounting to $50,968.

On the 27th of January, 1871, I forwarded to the Bureau a report of a reconnaissance of Little Red River, from Searcy Landing to its mouth, with approximate estimates for its improvement, amounting to $38,065. The total estimates for the three streams were $259,033.

Under date of August 6, 1870, I was directed to send a snag-boat at once into White River. In compliance with these instructions the snag-boat R. E. De Russy ascended White River to a point about three miles above Des Arc, where her further progress was interrupted by shoals.

The De Russy did good service in removing snags from that portion of White River over which she passed, but her draught is too great for operations in the upper portion of the stream.

PROPOSED OPERATIONS.

The act of Congress, approved March 3, 1871, makes an appropriation of $10,000 for the improvement of the White, Black, and Little Red rivers.

I find myself at great loss to determine the best method of using an appropriation of $10,000 for the prosecution of works for which estimates have been made amounting to over $250,000. It is evident Congress could not have intended any improvements of the character contemplated in the reports. As the best that can be done, I have recommended the expenditure of the appropriation in the removal of snags and trees, which figure largely in the list of obstructions.

Black and Little Red Rivers being tributary to White River, the transfer of a snag-boat from one stream to another can be made without trouble.

The snag-boat S. Thayer being the only light-draught boat of the fleet, my recommendation was to send her into White, Black, and Little Red Rivers, as soon as she could be spared from duty in the Missouri and Arkansas. My recommendation has been approved by the Bureau, and will be carried out as speedily as practicable.

The appropriation will keep a snag-boat at work in these streams for only about two months, which will render comparatively little service to navigation. If it is proposed to render the navigation of these streams the service which is practicable, it will be necessary to make appropriations somewhat commensurate with the work to be done. If, on the other hand, it is proposed to operate in them with snag-boats alone, then provision should be made for building a boat suitable for the purpose, and for keeping her at work at least six months of each year, or while the water is high enough for her to operate. The estimated expense for doing this is as follows:

ESTIMATE.

For building one light-draught snag-boat	$100,000
For running expenses six months, at $5,000 per month	30,000
For repairs and expenses in ordinary	5,000
Total estimate	135,000

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel Corps of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

I 12.

OFFICE WESTERN RIVER IMPROVEMENTS,
St. Louis, February 8, 1871.

GENERAL: I have the honor to submit herewith the report of Captain C. R. Suter, Corps of Engineers, upon his examination of Vicksburg Harbor, made under my direction.

The report, with the accompanying maps, sketches, profiles, &c., give a clear conception of the condition of affairs at that place, and make it evident that the apprehensions that the river will seek a new channel, leaving Vicksburg an inland town, are only too well founded, and the necessity for prompt, energetic action to prevent such a calamity is manifest, if, indeed, the time for action has not already passed.

There can be no doubt that the remedy proposed would effect the object in view if it could be promptly applied, and I see no more economical way of securing the result, or any which could be more speedily carried out. Still, I doubt if the work can be done in time to prevent the impending calamity. Hence if it is proposed to attempt to save the harbor of Vicksburg, it is of the greatest importance to commence at once.

By doing so, and beginning the revetment at the upper portion of the section which is now wearing away so rapidly, the action may possibly be so checked as to afford time to complete the improvement.

Very respectfully,

W. F. RAYNOLDS,
Lieutenant Colonel of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

OFFICE WESTERN RIVER IMPROVEMENTS,
No. 1122 Pine street, St. Louis, Missouri, February 6, 1871.

COLONEL: I have the honor to submit herewith my report on the examination of Vicksburgh, Harbor and vicinity, executed in accordance with your instructions of November 14, 1870, copies of which accompany this report. (Papers marked A, B, C, D, and E.) As neither funds nor time were available to execute a survey on the scale recommended by Colonel Macomb, I confined my examinations to the immediate vicinity of Vicksburgh.

A careful survey was made of the peninsula opposite the city, from the military canal to the point. This survey embraces all features of interest or importance, and was connected with all preceding surveys of which I could obtain maps. The left bank of the river was fixed by triangulation from the main line. A careful reconnaissance of this shore was also made from King's Landing to a point opposite the lower end of the canal, and the topography filled in; our survey was also connected with the city maps in the same manner. Two lines of levels were run across the point, viz, one along the course of the old canal, and one at the point where the cut-off seems most imminent. Frequent profiles were also made of the river bank. Borings were made at three different points on the cross-section line at the narrowest part of the neck. These borings give a very good idea of the disposition of the strata. The hydrographical work was confined to making with much care four characteristic sections of the river, viz, three on the upper and one on the lower side of the point.

The river, during my survey, reached a point 43.6 feet below the high water of 1858, as determined by the bench-mark left by the delta survey on the north wall of the Prentiss House. It was consequently at its lowest stage or very near it. All hydrographical observations are referred to this lowest observed level.

Accompanying this report are three maps, viz:

Sheet No. 1, showing the vicinity of Vicksburgh. This map embodies all the information collected by my surveys, and gives the shore-lines of 1828, 1865, 1866, and 1869 in addition. Scale $\frac{1}{12000}$.

Sheet No. 2 gives a sketch of the Mississippi River, from Terrapin Neck above to Grand Gulf below Vicksburgh. This sketch was made from the steamer Octavia in 1869 and 1870, and although not strictly accurate, yet is sufficiently so to give a good idea of the shape of the river in this vicinity. Scale one inch to one mile.

Sheet No. 3 gives to various scales the profiles, cross-sections, and borings executed by my party.

REPORT ON VICKSBURGH AND VICINITY.

The city of Vicksburgh possesses the most commanding site and the finest harbor on the Mississippi River. The city is built on the range of bluffs which form the southern limit of the Yazoo Bottom, and which at this point are directly on the river, the rock on which they rest cropping out at the water's edge. There is deep water along the whole city front, and, in fact, the entire width of the river is available for boats at all seasons, as there is not less than 25 feet depth in any part of it. Vicksburgh is situated in one of the finest cotton districts of the South, and is, in fact, the only available outlet for a good portion of Northeastern Louisiana and Western Mississippi. It is also the shipping point for the whole country bordering on the Yazoo and its tributaries.

Two lines of railroads converge there, viz, the Vicksburgh, North Louisiana, and Texas, in Louisiana, and the Vicksburgh and Meridian, in Mississippi. The terminus of the former road is at Delta, three miles below Vicksburgh, and on the other side of the river. It was originally at De Soto, directly opposite Vicksburgh, but that site was abandoned owing to the rapid encroachments of the river. These two roads, I understand, entirely fail to meet the demands made on them for transportation. The finest and largest packets on the Mississippi run between Vicksburgh and New Orleans, the trade being the most profitable one on the river.

Of the importance of Vicksburgh in a military point of view, but little need be said. It is a perfect Gibraltar against an attack either by land or water, and may truly be said to be the key of the Mississippi Valley. Its growth since the war has been considerable, and is steadily on the increase. The present value of taxable property in the city is estimated at something over seven millions.

In view of all this, it is not surprising that the inhabitants feel justly apprehensive of a catastrophe which would at once deprive them of all their present advantages, and force them either to remain an inland town or go to the expense of extending the business portions of the city indefinitely, to suit the changes which the eccentric river seems disposed to make. The conformation of the river in this vicinity is peculiar, and merits a brief description. Young's Point, Louisiana, is opposite the mouth of the Yazoo, and six miles due west from Vicksburgh. The course of the river at this point is a little south of east for three miles, till it reaches the head of the military canal, when it bends sharply to the northeast and maintains this direction till it reaches the bluffs on which Vicksburgh is built. It then turns abruptly on itself, running nearly parallel to its former course, straight past the city, and so on for a distance of about eight miles, when it bends back to the left to reach the town of Warrenton, Mississippi. This peculiar formation explains the fine harbor of Vicksburgh. The river is so concentrated by its abrupt change of direction on reaching the bluffs, the materials of which are substantial enough to prevent any great abrasion, that it is forced to scour out a very deep and narrow bed, which possesses a directness to be seen at no other point on the river. No changes of any consequence have taken place in this portion of the river, the shore-line of 1828 being almost coincident with the line of 1870. On the upper or northwestern side of the peninsula, however, the case is widely different. Near the upper mouth of the canal the direction of the river is changed so abruptly as to throw the whole current against the Louisiana shore. The soil is mainly composed of sand free from cementing materials. The water, even at a dead low stage, attains an average depth of 52 feet within 275 feet of the foot of the bank, and the average width of water-way being but 2,000 feet, the current attains a tremendous force to abrade the soft and yielding shore. The abrasion was gradual but constant until 1865, since which it has attained a rate of progress most alarming.

In 1828 the width of the peninsula at the site of the canal was 9,100 feet, and gradually diminished from this width to about 6,000 feet near the point.

In 1858 the width had been pretty uniformly reduced about 1,900 feet from that of 1828.

The maximum erosion amounted to 2,000 feet, which, for thirty years, gives a rate per annum of 66 feet. In 1865 the abrasion was still nearly uniform along the whole point. The maximum since 1858 was 440 feet, giving a rate for the seven years of 63 feet per annum, nearly the same as before. In 1866 a great change took place. The rate of abrasion at the upper end of the bend was enormously increased. It amounted during the year to 300 feet at the canal, 900 feet a quarter of a mile below, and 500 feet half a mile above Cramer's House. From this point the new shore-line gradually ran into that of 1865. This was the year of the formation of Terrapin Neck Cut-off.

Of 1867 and 1868 we have no information, but in 1869 a crevasse took the shore-line back some 1,400 feet on the line of the canal. This was exceptional, however, the regular abrasion amounting to some 950 feet since 1866, and it ceased a mile below Cramer's. This would give a rate of 317 feet per annum.

The shore now showed a deep re-entering below and in the neighborhood of the canal. This was partly reclaimed by new levees, but from 1869 to 1870 the greatest amount of damage was done. The main body of the river was shifted farther down the bend, the point of impact being just above Cramer's House, and the whole shore-line below there was changed to suit this new direction. The average amount of cutting was 940 feet, but the maximum was 1,500 feet, and that at the narrowest part of the peninsula. At the time of my survey the width at this point was 2,500 feet, which is all that now remains to prevent the river from breaking through. This same high water filled up the head of the bend considerably, the shore-line at the canal being now out beyond the line of 1866. A bar is rapidly forming above the canal and will doubtless soon extend down to the small point shown on the map. The intervening space is now occupied by an eddy—the main current only reaching the bank—near the broken levee above Cramer's House. The present width of the peninsula at the canal is 6,833 feet. Two and a half miles from here this width is gradually diminished to 2,500 feet. From this point it gradually increases, attaining a width of 3,200 feet within a mile of the point. The extremity of the peninsula has been continually elongated to keep pace with the cutting of the bank above the Vicksburgh Bluffs. Its extremity is now about 2,000 feet beyond the line of 1828, and is a little further down the river. As before stated, the changes in front of Vicksburgh have been very slight. Such "makes" as have been formed have been speedily washed away again, leaving the shore-line comparatively unchanged. There is therefore nothing to compensate for the wear above, and under the best of circumstances it would only be a question of time as to when the peninsula would be entirely washed away. At the rate given from 1828 to 1865 the peninsula would have out-lived this century; but if, as seems probable, the present rate of erosion should continue, two or three years would be sufficient to effect the cut-off. Terrapin Neck in 1858 is reported to have been 1,200 feet wide. In 1866, just previous to the formation of the cut-off, the width had been reduced to 450 feet, or a rate of abrasion of 94 feet per annum.

Davis, or Palmyra Cut-off was 2,700 feet across in 1858. In 1867, the year it broke through, it had been reduced to about 1,200 feet, or a rate of abrasion of 166 feet per annum.

In both these cases the neck was wearing on both sides, so that the actual rates of cutting were only half those given. This will give a good idea of the tremendous force now acting on the point in front of Vicksburgh. The fact, too, that at Davis' Cut-off the river broke through 1,200 feet in a single night, shows the imminence of the danger now threatening the city of Vicksburgh.

There is no doubt in my mind that the formation of these two great cut-offs was the cause of the very marked results visible since 1865. Their combined effect was to shorten the river some thirty miles with a proportionate increase in the water slope. The efforts of the river to regain its lost regimen are made evident by the rapid cutting going on in all the bends for some distance above and below Vicksburgh. It is only in this manner that the river can regain its original length and slope. Data are wanting to determine how nearly this result has been obtained, and consequently, it is impossible to predict when this excessive rate of abrasion may cease. (The low-water slope at the present time is three-tenths of a foot per mile.)

Moreover, the encroachments of the river in various places already complicate the question, as no man can foretell what the effect of certain changes now in progress may be. For instance, the river is encroaching very rapidly on the shore opposite Paw Paw Island. Already it is only separated from the Yazoo by a neck about 1,200 feet wide, and there is no reasonable doubt but that in a year or two it will break through into that stream. No one can doubt that the change of direction thus produced will have an important bearing on the river above Vicksburgh, but whether it will be for the better or for the worse it is impossible to say.

It is also necessary to state here that no great flood has taken place since 1867. It is only reasonable to suppose that a great flood rising above the banks will produce far greater effects than the comparatively small ones of late years. The borings executed under my directions gave most disheartening results. About five feet above the low-water level of the river a bed of blue clay 3 feet thick is met with. Above this is the usual sandy surface soil; 19 feet below the first layer of clay a second one 4 feet thick is met. The space between the two is filled with coarse sand, thoroughly permeated by the seip water from the river, and almost fluid; at a further depth of 19 feet a third layer of clay is met with, which is 18 feet thick; above this is quicksand as before. Twenty-eight feet below the third layer of clay is solid rock, and the space between is filled up with some substance too soft to be raised by the boring tools. It is probably an almost fluid quicksand. By referring to the sheet of cross-sections, &c., it will be seen that a large portion at least of the present river bed is in the third layer of clay; but the upper section, taken where the water-way is most contracted, (1,400 feet wide at the surface,) shows a depth which would carry it through this clay, and, in all probability, down to the rock. We therefore see that the whole extent of the upper side of the peninsula presents nothing to resist the action of the river but unstable layers of sand of great thickness, which are already permeated by the river water to a distance of at least 500 feet from the river itself, and probably much farther. In fact, there is nothing to show that the water does not already flow through from one side of the point to the other, and, indeed, the almost fluid condition of the lower strata points strongly toward that inference. The cutting action of the river merely washes out this loose sand, thereby undermining the clay layers, which finally break down under the superincumbent weight and precipitate considerable portions of the bank into the river simultaneously. Of course, the deeper the water the more rapid the cutting, from the increased hydrostatic pressure and the greater overhanging weight. The present bed of the river, as well as the slopes of the banks, are apparently covered with lumps of clay, which are lying as they fell, the sand having been all washed out from around them.

The precise course which would be taken by the river, in case the threatened cut-off should form, is hard to predict, but the effects on Vicksburgh Harbor are obvious enough. Should the river go through at the present narrowest part of the neck, the main channel would strike the Mississippi shore about two miles below Vicksburgh, and the tendency, for some time at least, would be to work farther down the river. The present harbor would soon be filled up with sand-bars, and as no affluent enters it of sufficient size to keep open a channel large enough for navigable purposes, the present city wharf would be entirely shut off from the river. The results of all previous cut-offs have shown conclusively that this filling up of the old bed is inevitable. It would be impossible to keep the upper end of the old channel open, although the lower end might be opened up by dredging. The channel thus obtained would, however, be too small and dangerous for large or heavily-laden boats, so that the city would be practically shut off from the river. There would, therefore, remain no alternative but to establish new warehouses, &c., at the nearest point available on the new channel, which would probably be some two or three miles from the present city wharf.

The worst feature about the change would be the loss of the bluffs and the stable river regimen which the city now enjoys, and which have been the main sources of its prosperity. There would also be a great uncertainty as to the stability of any new site which might be selected. The best and most economical method of preventing this calamity is not very obvious.

It is a favorite idea among non-professional people that it is the easiest thing in the world to change the course of a river in any manner desirable. In view of this fact, it is not surprising that parties interested in the matter should have broached a great number of schemes for preserving Vicksburgh Harbor, all of which are based on some idea of changing the course of the river. Now the chronicles of engineering science, while recording innumerable failures of works of this nature, mention but few successes. In fact, it may be safely stated that no problem in engineering offers more uncertainty as to the results and fewer chances of success. That successful works of this kind have been carried out is unquestionable, but it has been at a fabulous cost of time and money, and, at best, only on small or medium-sized streams. To apply such experience to a river like the Mississippi at Vicksburgh would be impossible.

To carry out any work of this kind, many years of preliminary observation are absolutely essential. To predict the effect of a cut-off or a change of direction in the river, it should be closely studied at all stages, and for several successive seasons, and the observations should extend over a sufficient portion of the stream to embrace the whole area of country likely to be most affected by the proposed change. Information thus obtained might be relied on to guide the judgment, but it is absolutely wanting in the present case. There remains, then, only the more obvious plan of endeavoring to protect the bank as it stands, and allowing the river to keep its present channel. There are two methods of accomplishing this result, viz: by jettees or continuous revetment. Jettees will certainly deflect the main current of a stream from a caving shore, but they form hurtful eddies between them which require the intermediate bank to be revetted. Their cost at Vicksburgh would be enormous, as the water at its lowest stage has a maximum depth of 67 feet, and they would require to be raised at the inner end to high-water mark, or 45 feet above low water, to prevent the river from washing around them. Moreover, as before stated, the intermediate shore would have to be revetted, so that, in my opinion, jettees would be far more costly than a continuous revetment, and also more uncertain.

The plan of continuous revetment I therefore regard as the most feasible. To carry it out in a thorough and substantial manner, it would be necessary to cover the slope of the bank, from low-water mark to the deepest portion of the channel, with a layer of broken stone, at least three feet thick. The stone could be dropped overboard from barges in the same manner as in forming a riprap.

From low-water mark the bank should be graded back to a level slope of one vertical to six horizontal, and the surplus earth used in the formation of a levee, with equal slopes inside and out, viz, one-sixth. The crown of this levee should be 10 feet wide and 48 feet above the low water of December 5, 1870, which, as already stated, is 43.6 feet below the high water of 1858. This would put the top of the proposed levee three feet above the highest water-marks on record.

The outer slope of this levee should be carefully paved one foot thick with stone, as far down as low-water mark. Such a structure would, it is thought, guarantee perfect immunity to the bank, as the interstices between the stones would soon be filled up with sedimentary deposits, thus forming a compact mass, which would protect the soft soil underneath from abrasion. The inner slope of the levee is made very flat, to avoid the chances of an overflow of the peninsula, which, without this precaution, would take the revetment in rear and wash it out.

The total length of shore to be thus protected is 21,000 feet, nearly four miles, and extends from the bar at the point into the eddy below the canal. It would be better and easier to do the subaqueous work at a low or at least a medium stage of water. The grading of the bank, &c., could of course only be done when the bank was uncovered. Stone of sufficiently good quality for this work can be obtained at Haines's and other bluffs on Yazoo River, and can be towed or rafted down in barges to the place of deposit. These quarries are about twenty-five miles from the work. To insure success, it would be necessary to have a large number of barges, and to accumulate a considerable quantity of stone before beginning the riprap. When once commenced, the work should be prosecuted with all possible dispatch, to prevent the river washing the bank away before the full covering could be placed on it. In fact, if anything is to be done here, it should be done very soon, as if the present rate of abrasion should continue for a year or two longer, it would be too late. It would also be highly important to have the whole sum necessary appropriated at once, to avoid any delays in carrying the work through when once begun.

The accompanying profile will give an idea of the plan proposed. It is thought to be a fair average section. The stone-work will amount to 880,444 cubic yards, which can be put in place for $2 a yard. The earth-work will amount to 2,177,700 cubic yards, which I have estimated at 20 cents a yard.

In a work of this magnitude, subject to so many delays, accidents, and unforeseen contingencies of all kinds, it would not be safe to put the contingent expenses at less than twenty-five per cent. The estimate will then stand as follows:

880,444 cubic yards stone-work, at $2 per yard	$1,760,888 00
2,177,700 cubic yards earth-work, at 20 cents per yard	435,540 00
Engineering contingencies, &c., 25 per cent	549,107 00
Total	2,745,535 00

Respectfully submitted.

CHAS. R. SUTER,
Captain U. S. Engineers, in charge survey Vicksburgh.

Lieutenant Colonel W. F. RAYNOLDS,
Corps of Engineers, U. S. A., Superintendent Western River Improvements.

I 13.

OFFICE WESTERN RIVER IMPROVEMENTS,
No. 1122 *Pine street, St. Louis, Missouri, October* 19, 1871.

GENERAL: I forward herewith a copy of a report from Captain C. R. Suter, Corps of Engineers, of the labors incident to getting the snag-boats S. H. Long and R. E. De Russy out of the Missouri River, which sets forth so clearly the difficulties of conducting the work under my charge with the appliances provided, that I deem it a duty to submit it to the Department as a supplement to my annual report on the improvement of the Mississippi, Missouri, and Arkansas Rivers.

It is true that the present low stage of water in all the western rivers is unprecedented, but it exists, and is liable to occur again, and while it exists we have the best opportunity to improve the navigation that we can have; but our work is stopped by the great draught of our boats. The simple statement is all the argument I propose to offer in regard to the necessity of a change.

The present hulls of our snag-boats are now four years old. The average life of hulls on these rivers is not to exceed six years. Other boats do their utmost to avoid all shocks and jars, and especially to avoid contact with snags, which it is the business of our boats to remove. To do this, all the strain which can be exerted by the most powerful machinery is frequently insufficient. In such cases the snags are "butted" with all force attainable by the combined power of steam and current. The shock is such that any other boats in these waters would go to the bottom at once, and the wonder is that wooden boats have been able to stand it as they have. Great credit is due my predecessor for the construction of boats as good as we have. But four years of this service has brought them to such a condition that already the annual cost of repairs is a large percentage of their original cost. This percentage will increase constantly, and, under the most favorable circumstances, two or three years more will render the hulls entirely worthless.

The machinery is all that could be desired. The upper works, as a general thing, are yet sound, and could be largely used on new hulls. I am satisfied that it is the true policy to at once prepare for replacing the hulls, which, in my opinion, should be of iron. The advantage of iron would be, superior durability, less weight, and no water-soaking to increase the weight, no calking to be jarred out by butting, greater strength, and less expense in annual repairs.

The construction of at least one iron hull should be commenced at once, so that we could have the advantage of the experience gained in the construction of the first before commencing the others. The hulls should be longer than those now in use, in order to gain floating power, and thus secure the lighter draught which is requisite.

I have little data upon which to base an estimate of the cost of such hulls as we require, but I do not think it would be safe to estimate the cost of rebuilding the boats in the manner deemed necessary at less than $50,000 each, or, for the three, $150,000, and I would respectfully recommend that an appropriation of that amount should be asked for.

Respectfully submitted.

W. F. RAYNOLDS,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

ST. LOUIS, MISSOURI, *October* 15, 1871.

COLONEL: I have the honor to report that, in accordance with your instructions of the 15th ultimo, received while working at Turkey Island, I left that place on the 16th, reaching St. Louis the same day. Having procured a pilot, we left St. Louis for the Missouri River on the 17th. I also dispatched a messenger to the snag-boat Long, by way of Booneville, Missouri, with instructions to start down the river at once. Our progress up the river was necessarily slow, owing to the very low stage of water and the great number of breaks to be avoided. On the 19th we met the snag-boat De Russy at Portland, Missouri. They had managed to lighten over Ewing's Bar and spar over St. Aubert's.

I directed Captain Birch to proceed carefully down the river, not taking any unnecessary risks, and also to remove such snags as would be in our way coming down. I then kept on up the river, and at midday of the 20th came up to the Long, hard aground on Sandy Hook Bar, not two miles from the place where my orders had reached her. It was a piece of gross carelessness on the part of her pilot, who had neglected to make his preliminary soundings extensive enough before starting in. During the balance of the day we worked at her, taking off extra weights and trying to pull her through. But it was no kind of use, as there was barely 3 feet on the bar, and the Long was drawing nearly 4½ feet.

The next morning I had the chute of 1000 Islands examined, and found over 4½ feet through it. We worked all the balance of the day and half the night to get the Long up off the bar, and the next morning started down through the chute with her. She came through all right, and both boats reached Ewing's without serious detention the evening of the 22d. There were two channels at this place, both long and shoal, and with about 3½ feet of water.

On the 23d, I attempted to dredge a channel through one of these places, but I found that it would consume too much precious time if any other method was feasible. We had discovered by this time, too, that the channel depth would vary to the extent of 3 or 4 inches in the course of a few hours. I therefore determined to lighten the Long to the greatest extent possible, and watch for a favorable chance to rush her through.

During the morning of the 24th, everything movable was taken off her, leaving her only the tackle, &c., necessary for sparring. We then dropped down below the bar, sounded, and found 3 feet 8 inches. I signaled the Long to try it. She came in and got nearly through before she stuck, and a couple of hours' sparring brought her through. On the 25th we got over St. Aubert's, but the Long stuck on Portland Bar, and failed to get over after working nearly all night. The next day she got up out of it to try it again, after we had dredged down some of the rough places. On the 27th she made another attempt, and got through by mid-day. That night she stuck again at Pannell's Island, but got over by morning.

The 28th we were more fortunate, reaching Emily Bend by night. Here we found the De Russy waiting for us, as she was stopped by shoal water (3 feet 8 inches) below her.

After sounding this place carefully on the 29th, the Long started in and got through safely. We then lightened the De Russy, as we had done to the Long, and she started in, but stuck, and did not get over till morning.

The lightening operation had brought the snag-boats up to 4 feet 1 inch in their deepest place, (amidships,) their ends drawing a little over 3½ feet.

The Octavia was loaded down to 3½ feet, and trimmed about even.

The next day (30th) we proceeded cautiously down the river, and by evening had reached Dozier's Bar, where we expected to have the most trouble. That evening and all the next day were spent in sounding, but the only channel we could find was about as bad as could well be, crooked and narrow, with two reefs to cross, and only 3½ feet in the best of it, for the width of the snag-boat hulls only 3 feet. Its shape was so peculiar that the Octavia could not work at it for want of room, and all our efforts to dig another channel were fruitless.

The least increment of the current, such as dredging of course produces, was sufficient to set in motion such masses of sand as almost to make a dry bar above us. I then determined to fall back on an expedient which I had resolved to adopt in such an emergency as this, viz: to build docks, and place them between the hulls of the boats.

October 3 I went down to St. Charles and procured lumber for this purpose. Work began in the afternoon of October 4, under the direction of Captain Wherry, of the Long. Everybody in the fleet assisted that was able to do anything useful.

The docks were built in three sections, and as large as could be introduced between the hulls. The total length was 140 feet, width 10 feet 4 inches, depth 3 feet 6 inches. They were light, flimsy structures, but served our purpose admirably. Their ultimate lift was 113 tons, which I had calculated would raise boats to 3 feet 2 inches, but the actual result was 3 feet 4 inches on the outside bilges, the inner ones being raised to about 3 feet. The ends of the boats came up to 2½ feet.

While the work on the docks was progressing, the condition of the bar got worse and worse. The river was steadily falling and contracting, and the frequent grounding of boats was gradually closing the gap up. The docks were finished, placed in position under the De Russy, and pumped out by the evening of the 9th.

The next morning there was only 2 feet 10 inches on the bar. The Octavia had to spar through, and hard work at that, as she was drawing 3½ feet.

All the arrangements having been made, the De Russy came in about 6 p. m. The crews of the three boats were on hand to boat wood from below the bar, lay hawsers, &c. Three and a half hours' conscientious sparring and hauling brought her over the upper reef, the shoal one, and in the morning she dropped over the lower one without much trouble.

The docks were at once filled, got out from under her, pumped out, and taken up to the Long. By evening they were under her, and she was ready to start in by 9 a. m. Unfortunately a small steamboat got the start of her, grounded, and lay in channel till late in the afternoon, and nearly filled it up. As soon as she was out, the Long started in. A high wind which was blowing prevented her striking it as favorably as the De Russy, but by midnight she was over the upper reef, and came over the lower one in the morning of the 13th. We made a late start that day, owing to the precautions necessary to tow the docks safely. That night we were at Hamburgh Landing. The 14th we reached Holmes's Island, five miles below St. Charles, and to-day, after much hard scrambling, we got out of the river, and came on down to St. Louis.

The logs of the different boats will give you an idea of the sounding, sparring, &c., incidental to this most arduous trip. I can only say that everybody on the boats, both officers and men, have worked faithfully and uncomplainingly whenever required. That the boats got out with no greater damage, is a matter of wonder. We were constantly dodging breaks, and hitting them also too frequently for comfort. The Long ran on one at L'Outre Island, which broke seventeen floors, and shivered two or three planks, but did no real damage. It would have sunk her, if it had not been for the additional bulkheads put in last spring.

Before concluding, I wish to state that the present low stage of water is unprecedented at this season. The lower end of Missouri River is now as low as it ever gets in the dead of winter, and the fall was so rapid and unexpected as to deceive every one. The De Russy neither experienced nor expected trouble until they got below Jefferson City, and the Long was in blissful ignorance of the state of things below them when they got my letter. Moreover, Captain Wolf, of the Abert, reported the river low, but plenty of water when he came out in the latter part of August. But the river fell some 3 feet in the meanwhile, about three weeks.

I have always been prepared for trouble of this kind, since the De Russy was caught in the same way in 1868, and have, therefore, always accompanied the large boats with the Octavia until this season, when she was ordered to other duties.

I am free to confess that this close supervision on an independent boat, free to come and go whenever and wherever necessary, is the only safe way to work in Missouri or Arkansas Rivers, and is desirable wherever the boats may be working.

But more important even than this is the necessity of some radical change in the boats themselves. They drew originally about 4 feet; now they draw 4½, which their great width renders fully equivalent to 5. Another season they will probably draw 5 feet actually, and then they will be almost useless. Even now we must submit to the mortification of being driven below Cairo, at the very time when our work between there and St. Louis can be done so thoroughly.

The Abert has already had to turn back from Turkey Island, and will probably need assistance to enable her to get back to Cairo. The other two boats will also have to get below Cairo before taking on their outfit again.

I am perfectly certain that new hulls could be built, and the present machinery, &c., transferred to them, and all desirable changes made, for $40,000 for each boat, the new boats to draw only 2½ feet, to be as strong and substantial as the present ones, and even better provided with the means and appliances for their special work.

If money or authority could be obtained for *repairs* of this character, it would be an immense benefit to western river commerce.

I am, colonel, very respectfully, your obedient servant,

CHARLES A. SUTER,
Captain U. S. Engineers, Asst. in charge F. O. U. S. Snag-Boats.

Lieutenant Colonel W. F. RAYNOLDS,
Corps of Engineers, U. S. A.

APPENDIX K 1.

UNITED STATES ENGINEER OFFICE,
Improvement of the Ohio River, Cincinnati, Ohio, July 3, 1871.

GENERAL: I have the honor to submit the following report of operations for the improvement of the Ohio River for the year ending June 30, 1871. The work has been under my direction throughout the past year. Mr. Thomas P. Roberts, for four years the principal assistant in this office, was finally compelled last January to give up his situation on account of severe and prolonged ill-health. I was fortunate enough to secure in his stead the services of Mr. William Weston, formerly one of General Warren's assistants. To both of these gentlemen, as also to Captain G. W. Rowley, consulting pilot, I am under great obligations. The office, which had been in Pittsburgh for over four years, was removed to this city, by your order, on the 1st of June.

WORKS ON THE RIVER.

Owing to the great irregularities in the depth of water in the river, and to the fact that the appropriation bills seldom pass until the low-water season is well advanced, it is generally necessary to permit contracts to run until the close of the second summer, in order to secure for contractors at least one full season of low water. The delays, required by law, of sending advertisements to Washington for examination before publication, of publishing thirty days in advance, of getting awards approved, and of executing contracts and bonds, are such that at least two months are always thus consumed between the date of receiving notifications of an appropriation, and the commencement of work by contractors. As these delays always occur at the time most favorable for river work, and as no work can be done during high water, or when the river is frozen, it is impossible to complete work as rapidly as at places where the depth of water is unchangeable, and hence the apparent slowness of operations on non-tidal rivers. An indirect disadvantage arises from the fact that though contracts may be made at once for the expenditure of the whole of an appropriation, it is generally impossible to actually make the expenditure during the fiscal year, and therefore the sum reported on hand at the end of the year conveys an erroneous impression of large available resources. As a general rule, the entire surplus of the old appropriation is expended within two months after it is reported as on hand.

FINANCIAL STATEMENT.

Available July 1, 1870, per last annual report	$42, 936 76
Appropriated July 11, 1870	50, 000 00
Allotted September 29, 1870, for special local surveys	3, 000 00
Received from sale of public property	207 00
Total	96, 143 76
Less overestimate of amount available from appropriation for snag-boats and apparatus for clearing western rivers	2, 389 15
Available for year 1870–'71	93, 754 61
Expended during year	68, 280 07
Balance	25, 474 54
Appropriated March 3, 1871	50, 000 00
Available July 1, 1871	75, 474 54

At the commencement of the fiscal year the following unfinished contracts were outstanding:

Number.	Miles from Pittsburgh.	Dams at—	Contractor.	Already paid on contracts.	Paid during year.	Yet due to complete contract.
1	27	Beaver Shoals	James Bradley	$2, 970 00	$2, 309 30	
2	485	Medoc	J. H. Dennis	450 00	8, 190 00	
			Maddox & Slemmens*		2, 682 00	$718 00
3	502	Rising Sun	Routh & Watts	3, 262 50	6, 537 50	
4	524	Warsaw	Myers & Kerr	6, 420 60	6, 264 00	

* Employed to complete the dam after the failure of the original contractor.

The amount necessary to complete these contracts, increased by the amount yet to be paid on Medoc Dam, (the contractor for which failed to comply with his contract,) being $26,700 80 in all, should properly be deducted from the nominally available $93,754 61, leaving available for new works at the commencement of the fiscal year, $67,053 81.

The following contracts were made for river-work, in accordance with an advertisement dated August 22, 1870:

Number.	Miles from Pittsburgh.	Place.	Contractor.	Kind of work.	Amount.
1	3	Brunot's Island	Charles Cable	Dam	$13,515
2	10	Merriman's Ripple	B. L. Wood, jr	Dredging	4,500
3	15	Deadman's Island	do.	Dredging	2,400
4	85	Twin Island	C. M. Cole	Dike	2,100
		Total			22,515

No contracts were made for removing wrecks or snags, as I was informed that the balance of the appropriation from which I expected to pay for such work was to revert to the Treasury, under a law of the last Congress. My subsequent information that this balance was not affected by the law in question, came at too late a date to permit contracts to be made for its expenditure last season. A small amount was expended for the removal of dangerous obstructions in cases that admitted of no delay. The amount left over is now being expended under contracts made last spring.

The following table shows the sums expended upon the improvement of the river during the past fiscal year:

Expended for work on Ohio River during year ended June 30, 1871.

No.	Miles from Pittsburgh.	Place.	Contractor.	Kind of work.	Amount paid.
1	3	Burnot's Island	Charles Cable	Dam	$6,894 96
2	10	Merriman's Ripple	B. L. Wood, jr	Dredging	(*)
3	15	Deadman's Island	do	do	3,200 00
4	85	Twin Island	C. M. Cole	Dam and dike	3,148 60
5	167	Marietta Island	Routh & Watts	Quarrying	†1,368 75
6	485	Medoc	J. H. Dennis Maddox & Slemmens	Dike	8,190 00 2,682 00
7	502	Rising Sun	Routh & Watts	do	6,537 50
8	524	Warsaw	Myers & Kerr	do	6,264 00
9		Belair Bridge and other places	C. M. Cole	Wrecking	2,715 00
		Total			41,000 81

* No expenditure. † Reserved percentage.

BRUNOT'S ISLAND, THREE MILES BELOW PITTSBUGH.

In accordance with a long petition received by me soon after my arrival in Pittsburgh, signed by the president of the Pittsburgh Coal Exchange and the principal coal-owners and coal-fleet and packet captains and pilots, requesting the closing of the left channel at Brunot's Island, and the concentration of all the water in the right or glass-house channel, I let a contract in September for this work. During the winter the contractor was employed in quarrying stone near Rochester, Pennsylvania, and on the 20th of May he commenced putting the stone in the dam. In order to accommodate local interests, I placed the dam at the foot of Chartier's Creek Ripple, instead of at the head, as I would otherwise have done. Work is progressing very satisfactorily, and the dam will probably be finished before the close of the season. It will undoubtedly greatly help the commerce of Pittsburgh.

MERRIMAN'S RIPPLE, TEN MILES FROM PITTSBURGH.

This is a particularly bad bar for coal-fleets, every season leaving it strewn with wrecks of coal-barges. The removal of the upper-shore bar was particularly requested by river-men, and as my views on this point agreed with theirs, I made the contract accordingly. Owing to the late date at which the contract was made, the contractor was compelled to postpone operations until this season. He commenced work on the 30th of June, and will probably finish before the close of this month; 61 cubic yards were removed on this day, leaving 4,439 cubic yards to complete the contract. If dredging alone does not give the requisite depth and security, it will be an easy matter to complete the work by building a dam from Neville Island out on the lower bar. I preferred not doing this until I would see the result of dredging alone.

DEADMAN'S ISLAND, FIFTEEN MILES FROM PITTSBURGH.

The contractor finished his work at this place last season, and it is so greatly improved thereby that I hear no further complaints. As there was no detailed survey of the locality on file in the office, and as I was compelled to make a contract before one could be made, the amount of dredging required was underestimated, and it did not accomplish all that I expected. When the dredge, now being built for the Ohio River improvement, is completed, I intend to finish the work as originally designed.

TWIN ISLAND, EIGHTY-FIVE MILES FROM PITTSBURGH.

The work at this place consisted in repairing the dam at the head of Upper Twin, which closes the channel to its left, and in building a dike from near the foot of the Upper Twin to a middle bar below. Much good was accomplished, but owing to various causes the amount of the contract proved insufficient, and a new contract was made this spring for 1,000 yards more. The work already done has greatly helped packets, but the coal-men complain of a difficulty in getting by the dike without striking it. It is believed that the removal of a shore-bar above will remedy the difficulty. The dredge-boat will do so during the ensuing fall.

MARIETTA ISLAND, ONE HUNDRED AND SIXTY-EIGHT MILES FROM PITTSBURGH.

The expenditure reported above for this locality was merely the payment to the contractor of the percentage reserved from his old contract for quarrying; the contract for boating and placing in the dam having been suspended for two years, was finally declared void.

MEDOC, FOUR HUNDRED AND EIGHTY-THREE MILES FROM PITTSBURGH.

The dam at this place is yet unfinished, through the fault of the contractor, who sublet the work, and utterly neglected it. His contract having expired, a special contract has been made with the former sub-contractors to complete the work. Unless something unforeseen should occur, it will probably be finished by the 1st of August.

RISING SUN, FIVE HUNDRED AND TWO MILES FROM PITTSBURGH.

The dam at this place has been finished. I regret to state that although it has somewhat improved the condition of affairs at this bar, still it has not come up to my expectations. I intend having the locality carefully surveyed this fall, with a view of ascertaining what further work is needed to make a satisfactory improvement. No detailed map is on file in the office.

WARSAW, FIVE HUNDRED AND TWENTY-THREE MILES FROM PITTSBURGH.

The dam here is finished, and has given satisfaction. It was somewhat injured last winter by ice, and after it has settled for a year or two it may need rebuilding.

REMOVING SNAGS AND WRECKS.

Though no contracts were made for this class of work, as explained before, some of it had to be done to protect navigation. In September Mr. C. M. Cole removed two sunken barges near the channel, just below Buffington Island, and three pieces of wrecks between the same place and Ground Hog Creek. In April the same contractor removed two sunken barges below the Bellair Railroad bridge, three wrecks of barges at Buffington, two snags near the mouth of the Big Sandy, one snag at Sunfish, and nine between the head of the Brothers and Guyandotte.

CONTRACTS AWARDED APRIL 27, 1871.

The appropriation bill for the fiscal year 1871–'72 having passed on the 3d of March, as soon as official notification was received of the amount of the new appropriation, advertisements were issued calling for proposals for various river-work under the new appropriation of $50,000, and under the balance of former appropriations.

The following contracts were made in conformity with these advertisements:

No.	Miles from Pittsburgh.	Place.	Contractor.	Kind of work.	Amount.
1	185	Twin Island	C. M. Cole	Dike	$1,300 00
2	168	Marietta Island	do	Dam	6,460 00
1		Ohio River above the falls	do	Wrecking	$74 per day.
2		Ohio River below the falls	Joseph H. Porter	do	$97 per day.

Proposals were also invited for dredging at Deadman's, Twin Island, Buffington Island, and at sundry points between Pittsburgh and Wheeling. Upon my recommendation, you decided to reject all of these bids, and authorized me to build a dredge-boat and two scows. The boat is now being built by the former contractor, B. L. Wood, jr., and will be specially adapted to the work on the Ohio River, for which she is designed. It is expected that the boat will be ready for service by the end of August. With a Government dredge-boat, all dredging will be done at cost, and I have no doubt there will be great saving to the appropriation, and that in all probability the boat will pay for herself in two seasons. The greatest advantage, however, arises from the fact that a Government dredge may be made to work continuously at the exact place where her services are most needed, and that all work can be done at once, instead of being delayed for a year, as sometimes happens under the contract system. The cost of the dredge and two scows will be $24,000.

WORKS UNDER CONTRACTS OF MAY, 1871.

Although these contracts are made under the new appropriation of March 3, 1871, for the fiscal year ending June 30, 1872, yet as work has already been done under them, it is a proper subject for report.

TWIN ISLAND, EIGHTY-FIVE MILES FROM PITTSBURGH.

Work at this place has not yet been commenced, as the contractor has also the contract for Marietta Island, and intends completing the work at that place before commencing at this locality. As there is but little required here, I feel confident that the work will be finished before the close of the present season.

MARIETTA ISLAND, ONE HUNDRED AND SIXTY-EIGHT MILES FROM PITTSBURGH.

The work of closing the Virginia channel at this locality is progressing rapidly, and, at the close of the fiscal year, 7,833 cubic yards of stone had been placed in the dam, leaving 3,117 cubic yards to complete the contract. It is believed that this work will finally settle a long-standing controversy in regard to the two channels, the details of which are fully reported in my report of the survey at the mouth of the Muskingum, which is printed as Report No. 15, of Executive Document No. 60, House of Representatives, third session, Forty-first Congress. The approval of my recommendation by the Board of Engineers on Ohio River Bridges, to whom the matter was referred, is also given in the same document.

The partial completion of this dam has already greatly improved the depth of water at Marietta, as well as on Carpenter's Bar, and there is every reason to believe that the completed dam will fully justify the expectations originally formed of it. The coal-men are still unconvinced, but a few trips through the Ohio Chute will doubtless dissipate their prejudices. The authorities of Marietta have complied fully with their pledges in regard to the removal of obstructions from the chute, and from Duck Creek and the Little Muskingum, and I anticipate no future trouble from snags.

WRECKING OPERATIONS.

The contractor for removing obstructions from the river between Louisville and Cairo commenced work on the 24th of June, and by the 30th had partially removed the wreck of the steamboat J. P. Webb, which was a very serious obstruction to the navigation of the channel to the left of Sand Island, between the foot of the falls and the mouth of the canal. It is expected that all the dangerous obstructions between Louisville and Cairo will be removed by the close of the season. The contractor for similar work between Pittsburgh and Louisville commenced work on the 3d of July, so that under his contract there is no work to be reported for the last fiscal year.

DREDGING.

The government dredge-boat and scows will soon be built, and during the season I propose employing them in completing the work at Merriman, (should the existing contract be insufficient,) in finishing the unfinished work at Deadman, in removing a bar just above Deadman, and another at Line Island, and a shore-bar opposite the Upper Twin, in removing a large bar at Buffington, and in taking off a very objectionable shore-bar at McCullum's Ripple. Other work will be attended to should the season permit.

SURVEYS.

There is a great lack of detailed surveys at bad places on the river. This deficiency was partially remedied last season, and I propose continuing the work throughout the present summer and fall. The permanent party attached to the improvement under charge of Mr. W. Weston is now engaged on this work, and by the close of the season we will probably have secured reliable maps of all the bars that are most in need of improvement. In future, whenever appropriations of sufficient size are made, it will be within the power of the engineer in charge to plan works of improvement intelligently, and with a reasonable prospect of success.

ESTIMATES FOR NEXT YEAR.

For building dams on the Ohio above Louisville	$144,500
For building dams on the Ohio below Louisville	195,000
Current expenses and repairs of dredge and scows	12,000
New survey and inspection steamboat	12,000
	363,500

I think that this entire amount could be judiciously expended. There certainly is an urgent need of larger appropriations than those of the last two years—$50,000 each year. For a river one thousand miles long, with a commerce estimated at over $500,000,000, the sums lately appropriated are insignificant. Much good has been done with them, but with small appropriations, the sums necessarily consumed in office and inspection work are almost as great as when a large quantity of work is under way, and they are a serious reduction of limited appropriations. The surveys being made this season will enable us to expend every cent asked for above, with great advantage.

CONCLUDING REMARKS.

Lights and buoys.—A system of lights and buoys is greatly needed on this and other western rivers. It is more than ever necessary now on account of the number of bridges that span all western rivers except the main Mississippi. At present, for the lack of range-lights, coal-fleets are unable to pass any railroad bridge at night, thus losing valuable time and adding to the length and cost of their trip, with increased hazard to themselves and additional cost to consumers. If a proper system of lights were established, it is believed that it would be as easy to run bridges at night as in the day-time. A bill for this purpose was introduced at the last session of Congress, but it was not acted upon. It is to be hoped that the next Congress will not overlook the matter, and that navigators will be sufficiently sensible of their interests to compel the attention of the National Legislature.

MISCELLANEOUS WORK DURING THE YEAR.

Survey at mouth of the Muskingum.—This survey was made as ordered, and my report is printed in Ex. Doc. No. 60, House of Representatives, third session, Forty-first Congress.

International bridge at Buffalo.—I was detailed as a member of the Board of Engineers convened to consider and report on this bridge. Our report was completed and forwarded last February. As far as I am aware, it has not been printed.

Ohio River bridges.—I was also detailed as a member of the Board of Engineers convened to report upon all bridges over the Ohio River, giving all dimensions, &c., with instructions to specify such as were injurious to navigation, and to make an estimate of the cost of the changes required to prevent such injury. We made three reports, which are printed in full in Ex. Doc. No. 1, Senate Special Session, Forty-second Congress.

Survey at head-waters of the Monongahela.—This survey was ordered at the last session of the last Congress. I have delayed commencing it, in order to do the work during low water. The survey will probably be begun on the 1st of August, and it will probably require one month's field-work.

Survey of Licking River as a harbor of refuge.—This survey was also ordered at the last session of the last Congress. I have postponed it also, in order to make it during the lowest water of the season. It will probably be begun in August, and be finished in a few weeks.

Water-gauges on the Mississippi and tributaries.—The act of Congress of 21 February, 1871, directed the establishment of water-gauges at the following points on the Mississippi River, viz: St. Louis, Cairo, Memphis, Helena, Napoleon, Providence, Vicksburgh, Red River Landing, Baton Rouge, and Carrollton; and at the following points on the principal tributaries, viz: Fort Leavenworth on the Missouri, Rock Island on the Upper Mississippi, Louisville on the Ohio, Florence on the Tennessee, Jacksonport on the White, Little Rock on the Arkansas, and Alexandria on the Red River. Owing to the continued high water that has since prevailed throughout the South, the work of establishing these gauges has necessarily been postposed until the low water of the fall. It is my intention to establish all the up-river gauges in August, and the others as soon thereafter as practicable. It is impossible during high water to establish a gauge that can be read during all stages, and as at many points observers cannot be found who will be able to prolong the rods as the water falls, it has been thought best to postpone the whole matter until a time when the entire work can be both begun and completed.

Respectfully submitted.

WM. E. MERRILL,
Major Engineers and Brevet Colonel.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

K 2.

OFFICE OF OHIO RIVER IMPROVEMENT,
Pittsburgh, Pennsylvania, October 21, 1870.

GENERAL: In accordance with the instructions contained in your letter of the 23d July, I have the honor to report that I have made a careful survey at the mouth of the Muskingum River and in its vicinity, and submit the following report thereon:

My first care was to ascertain the intent of Congress in ordering the survey. The Muskingum River is directly navigable for a distance above its mouth of only 300 yards, as at this point there is a dam, which is the commencement of slack-water navigation. I could not believe that a survey of the Muskingum itself was contemplated by Congress, and accordingly I made diligent inquiry at Marietta, to ascertain the wishes of the persons at whose instance this survey was ordered. After consulting with the mayor and the principal citizens, I came to the conclusion that the intention was to have such a survey made of the Ohio River, above the mouth of the Muskingum, as would serve to settle the long-agitated question as to which side of Marietta Island should be closed.

Accordingly I commenced my survey at the mouth of the Little Muskingum, and continued it to a point a quarter of a mile below the mouth of the Muskingum, including the channels on either side of Marietta or Kerr's Island. The extreme limits of the survey are four and a quarter miles apart. I also gauged the flow of water in each channel, the river at the time containing about 9 feet of water, and therefore being at the proper stage for coal-boats.

At present the Ohio River at Marietta Island is bad in both channels at low water, and the bars in the two channels are about the worst in this portion of the river. Carpenter's Bar also, one and a half miles above the head of the island, is a bad place, and requires improvement. I made no special examination of this bar, as I believe a dam across either of the channels will so back up the water in the river as to make the bar as good as other places.

It is generally conceded that where the Ohio is nearly equally divided between two channels, neither is good in low water, and in such cases it is usual to close one of the channels and to turn the entire body of water into the other. The existence of this necessity at Marietta Island has long been recognized, but there are two opposing parties in interest who have hitherto prevented any action in the case.

The map accompanying this report shows clearly the island and the two channels. In the Virginia channel the two bars are near the head of the chute, and at the time of the survey there was 6 feet on each. In the Ohio channel one of the bars is just below the mouth of Duck Creek, and the other is at the mouth of the Muskingum; on both the depth was 5 feet.

The Virginia channel shows a width at the narrowest place of 740 feet, and the Ohio channel of 530 feet.

The amount of water discharged through the two channels was measured three days before the survey began, when the river was about 3 feet deeper than when the soundings were made. At that time I found, by the Humphrey-Abbott's method and formulas, the discharge to be as follows: Ohio channel, 13,057 cubic feet per second; Virginia channel, 22,446 cubic feet per second, dividing the entire discharge, as follows: Ohio channel, 37 per cent.; Virginia channel, 63 per cent. Inasmuch as I was compelled by circumstances to select a point above the mouth of Duck Creek for the measurement of the discharge of the Ohio channel, thus neglecting the amount contributed by this tributary, and as the river was about an inch lower than when I measured the discharge of the Virginia channel, I have concluded it would be more exact to define the relative flowage of the two channels, thus: Ohio channel, 40 per cent.; Virginia channel, 60 per cent. Summing up these results, we see that of the two the Virginia channel at the coal-boat stage is about 1 foot deeper and 200 feet wider, and discharges three-fifths of the entire volume of the river. Were these the only considerations to be noted, it is manifest that the Virginia channel would unquestionably be the one to be chosen for the main channel of the river. The objections to this choice are the following:

On the Virginia side there are no local interests concerned in the possession of a navigable channel. The only town on that side is Williamstown, below the foot of Marietta Island. This is a place of so little importance that although I spent two weeks at Marietta, making the surveys, &c., no one from the Virginia side of the river made any representations to me on the subject.

On the Ohio side we have the flourishing town of Marietta, of 5,000 inhabitants, the citizens of which are unanimous in their opposition to the closure of their side of the river. The party that favors the retention of the Virginia channel and the stoppage of the other, is limited to a portion of the coal-boat interests of Pittsburgh.

The question of the present relative magnitude of the two channels, I consider to be of no importance, as either channel would be sufficiently enlarged by the current were the entire river to be turned into it, and the advantage would be rather with the narrower channel, which would necessarily deepen more than the other, in order to accommodate the increased flowage. The bars in the Ohio channel are formed by the sedimentary deposits of Duck Creek and of the Muskingum, and would be more readily removed by an increase in the volume of water than those in the Virginia channel, which are of coarse gravel. Were the river to be turned into the Ohio chute, there would be but little danger of the continued growth of these bars, as they are probably due to the present slackness of the current. It is so simple a matter to put the river into either channel, and to maintain it there, that I think we may entirely neglect the question of magnitude, especially as the difference is not great. The objections which the coal-boatmen urge to the Ohio channel, are that it is narrower and more crooked than the other; that it is full of logs, and that they always use the other channel. The first objection amounts to but little. The map shows that the difference in curvature in the two channels is but slight, and that the width of the Ohio channel is more that twice that of the widest tow, and more than that of many other places that are habitually run without remark. River pilots are naturally conservative, and very unwilling to attempt new channels, but a few trips will probably remove their objections.

The only point that really deserves careful consideration is the complaint that the Ohio channel is dangerous from logs. This is a valid objection, experience having shown that hitherto there have been more obstructions on the Ohio side than on the other. Most of them seem to come from the Little Muskingum, with probably a few from Duck Creek. The former stream enters the river from the Ohio side, about two-thirds of a mile above the head of the island bar. It occasionally sends out snags which mostly lodge in the Ohio chute.

Believing that if this one objection were effectually removed, the coal-boat interests would cease to oppose the closing of the Virginia channel, I made this statement to the mayor and council of Marietta, and they at once hired a snag-boat and removed all the snags that could be found in the Ohio chute. They also, at my recommendation, sent parties of axmen up Duck Creek and the Little Muskingum to cut up and remove all snags, and trees likely to become snags, so that no more obstructions might be carried into the river from these streams. After making my first survey I went down to examine the dams below Cincinnati, and on my return I carefully examined the work done in the river, and found that the channel was entirely clear. Captain Rowley, the consulting pilot, examined the two tributary streams in a skiff, going up each about three miles, until a dam and rapids stopped him, and reported that except at one or two specified places the work was satisfactorily done. The snags and trees to which he called attention were at once removed, and I feel secure in reporting that there is no present or prospective danger from snags in the Ohio channel of Marietta Island. To make assurance doubly sure I requested the authorities of Marietta to guarantee the repetition of this work for five years. This they have done, as shown by the letter hereto annexed, and marked A.

I have also called their attention to the dike extending downward from the foot of Marietta Island, which narrows the Ohio channel so much, that I was afraid that it might require removal. They have also agreed in the letters marked B and B[1] to do this at their own expense, should the channel be kept up on their side of the island.

The commerce of Marietta is fully represented in the accompanying communication marked C, which the mayor informed me faithfully represents the present commerce of the place. The Marietta and Pittsburgh Railroad, a new enterprise, which at present only runs to the coal-mines of Morgan and Monroe Counties, distant about twenty-five miles, strongly protest against any closing of the Ohio channel. Their coal-landing has been placed just above the town, and they dread its sacrifice by a dam above. They also expect to do a large business in tobacco, lime, fire-clay, &c. If cut off from the river channel where they are now, they will be compelled to seek it above the head of Marietta Island, or traverse the town, cross the Muskingum River, and make a new landing in Harman. Their protest through their president, General A. J. Warren, is hereto annexed, marked D, as also a map of the road, marked D[1]. The question of closing one of the channels at Marietta Island has been agitated for the last thirty years, and is still a source of annoyance and dread to all parties interested. It is obvious that the river must be concentrated, and the parties in favor of either side can never be brought to agree. I append a petition, marked E, of many steamboat men, urging the retention of the Ohio channel, and a similar one against it from coal-boat men, which I have marked F.

There is no doubt in my mind that the closure of the Ohio channel will ruin the commerce of Marietta. Closed channels generally keep their depth above dams, but invariably fill up below them. When we add to this cause the amount of sediment brought down by Duck Creek and the Muskingum, which will no longer be swept away by a river current, we can see at once that there would be no chance left of keeping a channel open to the Marietta landing, nor to the railroad coal-landing above.

I conceive that nothing but the direst necessity can justify the deliberate destruction of a town of 5,000 inhabitants, the first settlement in the State, and that should it apparently be necessary to destroy the outlet which nature gave it, the Government ought to provide another at whatever cost. But in the case in question I cannot see that there is need of injuring any one. Marietta has removed all obstructions, and has taken every precaution to prevent any new ones from coming, by cleaning out the streams that furnish them.

There is no sacrifice within their means which its citizens are not ready and willing to make, as they know that the value of all their property is at stake. They have done everything that I suggested, and promised everything for the future that I thought it just to ask, and in return I feel it my duty and privilege to strive to protect their rights, and in fact their municipal existence. The question must be settled now, as it is unbecoming the dignity of the Government of the United States to let it remain open any longer, to the prejudice of the entire river interests. Scarcely any work has been done on the river which some one has not at first opposed, and afterward acknowledged to have done good. It seems there is but one way in which this matter can possibly be settled, and therefore I earnestly recommend that I be allowed to build a dam across the Virginia side, a little below the head of the island. If speedy action is taken I may get most of it in before winter, as the stone has been ready for over a year. I would prefer locating the dam as far below the head of the island as practicable, in order to prevent the draught over the dam in high water from tending to draw boats out of the channel. This is a defect in dams made in the prolongation of an inland shore, and moreover their extreme length greatly increases their cost.

Respectfully submitted.

WM. E. MERRILL,
Major of Engineers.

Brigadier General HUMPHREYS,
Chief of Engineers, Washington, D. C.

K 3.

STEUBENVILLE, OHIO, *December* 1, 1870.

GENERAL: Your letter of instructions of November 18, and accompanying papers in relation to improving the Ohio River in the vicinity of Marietta Island, were duly received.

The board having visited the locality and examined the questions involved, are of the opinion that the low-water navigation requires a dam to be placed across one of the channels to increase the depth of water in the other. That the width and direction of the channels admit of either being selected, and that they do not differ essentially in their capacity to accommodate the river commerce. That the closing of the channel on the Ohio side of the island will be a serious injury to Marietta, a town of 5,000 inhabitants, while there will be no corresponding injury to any other interests by closing the channel on the Virginia side of the island.

We therefore recommend the construction of a low-water dam on the Virginia side of the island, at such point across the channel on that side as the engineer in charge of the Ohio River improvement may select.

Respectfully submitted.

G. K. WARREN,
Major of Engineers.
G. WEITZEL,
Major of Engineers.
WM. E. MERRILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

K 4.

APRIL 19, 1871.

GENERAL: The board of engineers appointed by your order, in accordance with section 5 of the act making appropriations for the improvement of rivers and harbors, approved July 11, 1870, have the honor to submit this their final report. They have already submitted two partial reports, the first of which discussed the Newport and Cincinnati bridge, (it is Appendix D of this report.) The second gave the project of a law for the future regulation of bridges over the Ohio River, with the reasons for the various specified provisions; (it is Appendix E of this report.) With this their third and last report, they believe that they have completed their duty in regard to the bridges built or being built over the Ohio River.

Before commencing the detailed discussion of the bridges over the Ohio, it will probably be advisable to state a few facts about the river itself.

The Ohio River is formed by the junction of the Monongahela and Alleghany at the city of Pittsburgh, and thence it flows in a general direction a little south of west to its junction with the Mississippi at Cairo. In its upper course, especially between Pittsburgh and Wheeling, it flows over a bed of coarse gravel and boulders, and sometimes of rock, which is but little liable to be moved by an increased velocity to the current. Below Wheeling the gravel becomes finer, the boulders fewer, and bars of river-sand appear. This condition of increasing fineness in the materials of the bed continues to the falls at Louisville. Below the falls the river changes very decidedly, assuming the character of a river with a movable bottom, which it maintains to its junction with the Mississippi.

The slope of the river-surface, at low water, varies in the same manner. The following are the average slopes: From Pittsburgh to Wheeling, (ninety miles,) 10.44 inches per mile; from Wheeling to Letart's Falls, (one hundred and forty-one miles,) 7.42 inches per mile; from Letart's Falls to Louisville, (three hundred and sixty-six miles,) 4.68 inches per mile; from Portland to Cairo, (three hundred and sixty-five miles,) 3.05 inches per mile.

The declivity of the river-slope at what is known as "The Falls of the Ohio," at Louisville, has been omitted from the averages given above. It is 25.7 feet in four miles. The entire length of the Ohio River is nine hundred and sixty-seven miles.

The widths of the river, as might be expected, increase gradually from its head to its mouth. The following are the widths between banks at various points:

Distance from Pittsburgh.	Place.	Width.
Miles.		*Feet.*
2	Allegheny City	1,100
88	Two miles above Wheeling	900
183	Parkersburgh	1,200
285	Little Guyandotte	1,200
353	Portsmouth	1,050
467	Cincinnati	1,100
592	Six miles above Louisville	2,500
603	New Albany	1,500
682	Flint Island	2,700
782	Evansville	3,000
852	Five miles below Shawneetown	2,300
920	Paducah	3,500
959	Mound City	4,000

In low water the river does not occupy the entire space between the banks, and at the bars it becomes very narrow. The following table shows its low-water width at several of the more prominent bars:

From Pittsburgh.	Name of bar.	Low-water width.
Miles.		*Feet.*
10	Merriman	250
214	Buffington	250
455	Four Mile	1,000
502	Rising Sun	350
682	Flint Island	500
765	Scuffletown	900
943	Head of Grand Chain	1,800

It will be observed that these widths increase gradually except at Four-Mile Bar. At this point the river is quite wide and shallow, and the bar is not well defined like the others, but partakes of the nature of a shoal. Were the volume of the river concentrated, the width would probably be about the same as at Rising Sun. At extreme low water, which, however, only occurs at irregular intervals, the depth on the bars is about eighteen inches above the falls, and about thirty inches below.

The greatest flood ever known on the Ohio, above the mouth of the Wabash, was that of February, 1832. Below that point the flood of March, 1867, was the highest known, being 6 inches higher at Caseyville and 3 feet higher at Paducah. The following list shows the heights above low water of these floods at various points:

Distances.	Place.	Rise.	Flood.
Miles.		*Feet.*	
0	Pittsburgh	35.6	1832
67	Steubenville	45	1832
90	Wheeling	43.5	1832
94	Bellaire	50	1832
183	Parkersburg	50	1832
232	Letart's Falls	58	1832
267	Gallipolis	54	1832
466	Cincinnati	62.5	1832
598	Louisville	44.5	1832
603	New Albany	63.6	1832
920	Paducah	52.25	1867
964	Cairo	52.4	1867

The only continuous records of the rise and fall of the Ohio that we have been able to obtain, are those at Pittsburgh, Wheeling, Cincinnati, and Louisville. The last three will be found in the reports on the bridges at those cities. As the bridges are discussed in the order in which they are met in descending the river, this is probably the most suitable place for giving the Pittsburgh record. The depth of water at Pittsburgh determines the departures of the coal fleets. The coal-mines are all up the Monongahela, except a few along Saw-Mill Run, and the coal-barges come down one or two at a time through the locks and dams of the Monongahela slack-water. They accumulate in the harbor of Pittsburgh until there is 7 feet or more in the river, and then they are formed into fleets of from eight to twenty boats and barges, and are pushed down the river by powerful tow-boats. The steamer is always in rear of the fleet with about two-thirds of her length projecting behind.

The tables not only show the average duration of each stage, but also the maximum duration of the higher stages. They have been prepared from the official records from August, 1854, to March 1, 1871. These records are continuous, omitting Sundays, up to date. The water is gauged by the pier-marks on the Monongahela bridge, about a mile above the junction of the Monongahela and Allegheny, the zero being so placed that the gauge shows the depth of water on the Glass-House Ripple at the head of Brunot's Island.

RIVER-RECORD AT PITTSBURGH.

Average duration of each stage.

Month.	Depth in feet on Glass-House Ripple.								
	5	6	7	8	10	15	20	25	30
January	21.1	16.9	11.8	8.4	4.2	1.1	0.2	0.2	0.1
February	20.1	16.3	13.5	10.9	5.5	1.1	0.2	......	......
March	28.9	26.0	22.0	18.0	11.6	2.4	0.4	0.1	0.1
April	28.9	26.4	22.6	18.4	11.1	2.4	0.4	0.1	......
May	24.4	19.7	14.2	10.1	4.9	0.8	0.4	......	......
June	13.6	9.4	6.6	4.4	2.4	0.5	......	......	......
July	7.8	5.2	3.3	2.2	0.6	......	......	......	......
August	7.0	4.5	2.1	1.1	0.2	......	......	......	......
September	7.1	5.2	3.8	2.6	1.2	0.2	0.1	0.1	0.1
October	7.5	5.0	3.1	2.4	1.0	0.1	......	......	......
November	14.5	10.2	7.6	5.0	2.3	0.4	0.1	......	......
December	22.8	18.5	14.5	11.1	5.6	0.9	......	......	......
In each year	203.7	163.3	125.1	94.6	50.6	9.9	1.8	0.5	0.3

Maximum duration of high stages.

Month.	20.		25.		30.		High water of 1832.
	Days.	Year.	Days.	Year.	Days.	Year.	
January	4	1862	4	1862	1	1862	......
February	2	1867	......	......	......	......	35.6
March	3	1865	2	1855	1	1865	......
April	2	1859 1860 1862	2	1860	......	......	......
May	3	1858	......	......	......	......	......
June	......	......	......	......	......	......	......
July	......	......	......	......	......	......	......
August	......	......	......	......	......	......	......
September	2	1861	1	1861	1	1861	......
October	......	......	......	......	......	......	......
November	1	1860	......	......	......	......	......
December	......	......	......	......	......	......	......

Each bridge will now be taken up in regular succession from the sources to the mouth of the Ohio, the first one being that at Steubenville, sixty-six and one-half miles below Pittsburgh. The United States laws appointing the board, and those authorizing the construction of the various bridges, are all to be found in Appendix A.

STEUBENVILLE BRIDGE.

This is a single-track railway bridge now belonging to the Pittsburgh, Cincinnati and St. Louis Railroad Company, and it was built in 1862–'63, being the first railroad bridge constructed across the Ohio River. The law authorizing its construction (act approved July 14, 1862) gave the bridge authorities the option of building a continuous bridge 90 feet above low water, with a channel span of 300 feet, or a draw-bridge, 70 feet above low water, with a channel span of 300 feet, and a pivot-draw with two openings of 100 feet each. At the time this law was passed the question of the proper relations between river and rail transportation, though much discussed in the case of the bridge at Wheeling, was still an unsettled one, and the river interest had not come to a definite conclusion as to what it could safely concede in the matter of height and width of channel, while the railroad interest was equally uncertain as to what lengths of spans could safely be used for iron truss railroad bridges. This bridge was, therefore, in a great measure, an experimental one, to be judged of by its results. At the time of its construction no iron truss bridge of 300-foot span had yet been built in this country; and railroad men looked upon the 327-foot truss for the passage of the channel with no small apprehension. Bridges on the tubular, girder, and other systems, of greater spans, had been constructed abroad, but they were very costly, and were constructed on principles that were not regarded favorably by American engineers. The Niagara Railroad suspension bridge was also on a plan that had many decided opponents. In giving a 300-foot opening, the bridge-builders thought that they had yielded to the river interest all that could possibly be claimed, and more than was altogether safe for themselves. It is but just to state that they seem to have acted in good faith and with no disposition to cause any more trouble to opposing interests than was inseparable from the erection of any bridge whatever over the river. The origin of the provision for a low bridge with a draw was somewhat curious. The passenger steamers, apparently unwilling to lower their chimneys, insisted upon a draw for their individual accommodation, and were willing to have the bridge made 20 feet lower to procure one. Fortunately this provision was made optional with the bridge company and was not used. Time and experience have shown the utter incompatibility of bridges with draws with the peculiarities of Ohio River navigation. At the time when this option was conceded, the great coal-towing trade, at present the most important on the river, was yet in its infancy, and its great increase in the ensuing decade was not foreseen. Coal was then transported in single flat-boats, and the fleet system, to which draw-bridges are specially injurious, was just coming into vogue. Fortunately for both parties, the company decided on a high bridge, without a draw, and thus a barrier, that might have greatly crippled the coal trade from the start, was not erected. This bridge, from abutment to abutment, has a total length of 1,895.4 feet, and consists of eight spans of Linville or keystone trusses of the following lengths, from center to center of piers, commencing at the Ohio abutment, viz: 210, 210, 214, 327, 236, 235.7, 235.7, and 235 feet. The distance apart of the channel-piers at the low-water line, measured on the line of the bridge, is 303¼ feet; but the space available for navigation is much reduced by riprap around the bases of the piers. At the Ohio channel-pier the riprap at low water projects 7 feet into the channel, and extends 4 feet above the water-surface. At the Virginia channel-pier it projects 6 feet, and rises 1 foot above the water. The available space for navigation is thus reduced to 290 feet, and this diminution continues until the water is 12 feet above low water, at which time coal-boats can pass over the riprap on either side, which they cannot do when the river is lower. But at certain stages, this practicable space is still further reduced by the obliquity of the piers. At the time of our surveys, the river stood at 10 feet by the pier-marks, or at 9 feet above low water, as shown by our levels. At this time our observations for the directions of the current showed that, above the bridge, it made angles of from 14° to 15° with the axes of the channel-piers, and that below, the angles varied from 10¼° to 16°. General G. K. Warren made similar observations in June, 1868, at a time when the river was 4 feet above low water, and found that the current then made an angle with the Ohio channel-pier of 15°.

It is well known to all navigators that the direction of the current through the channel-span of this bridge varies with the stage of water in the river. Its direction in low and in moderate water is almost entirely determined by the middle or ferry bar, on the edge of which the Virginia channel-pier is located. As the river rises, this bar has less influence, and, in high stages, its effect is imperceptible, the river current being entirely determined by the shape of the bend above. At 4 feet above low water, as just mentioned, the current draws on the Ohio channel-pier, striking it under an angle of 15°. At 9 feet this angle is about 14½°. At higher stages it is said the current commences to straighten. At 13 feet it is about parallel to the piers, and as the depth increases it draws more and more on the Virginia pier. These changes in direction are among the greatest sources of trouble to tow-boat pilots, as their fleets are managed mainly by the current, and, therefore, navigators must be well posted as to the exact stage of water at the bridge, and the resulting direction of the current, before attempting the passage. Add to this the narrowness of the space and the possible obscurity of the atmosphere from river fogs and mists, or from the smoke of the mills at Steubenville, and the reasons for the accidents at this bridge are at once apparent. The range of the current cannot be less than 30°, from 15° on one side of the axis of the piers to at least the same on the other side. If the range be equal on both sides, (we have no high-water observations by which to determine this point,) it follows that the piers occupy the mean position, and, therefore, are "parallel to the current of the river as near as practicable." But it is evident from these facts that the locality is one entirely unsuitable for a bridge, besides the fact that it is on one of the permanent bars, where, at low stages, the river is most shoal and most swift. At such places we might naturally expect the greatest variations in the course of the current. In the pools, on the contrary, the direction of the current is very nearly the same at all stages, and at such places only should bridges be allowed to cross. But it must also be stated that these principles were not well known at the time when this bridge was located, and the company building it very naturally chose the locality that best suited their general line. At low water the natural section of the river is 3,179 square feet, of which 604 square feet, or 19 per cent., is occupied by the piers of the bridge. At high water the total section between the high-water marks is 77,189 square feet, of which 7,342 square feet, or 9½ per cent., is occupied by the piers and the riprap about them. The approximate discharge of the river at the time of the observations, as measured 300 feet above the bridge, was 37,858 cubic feet per second, with a mean velocity of 3.883 feet per second, or 2.65 miles per hour. At this stage the water-way at the bridge is as great as it is above the bridge, the increased depth between the piers compensating for the partial occupation of the section. The maximum observed velocity through the channel space was 4.35 feet per second, or three miles per hour.

The channel-span is what is known as a "through" or "overgrade" bridge, with the track on the bottom chord; the other spans are "deck" or "under-grade," with the track on the top chord. In consequence of this arrangement the tops of the channel-piers are 89 feet above low water, and the tops of the piers are 66⅔ feet above, the difference between them being the depth of the trusses of the short spans. There is neither grade nor curvature on the bridge.

The channel-piers are of substantial stone masonry, with a section on top 42 by 17 feet, which includes a coping projecting 4 inches, and at low-water line of 78½ by 23¾ feet. The sides have the usual batter of one-half inch per foot, and the tops have the usual cut-stone coping. The up-stream ends are provided with ice-breakers, with a batter of 9 inches to the foot, and a triangular cross-section rising to a height of 41 feet above low water; above the ice-breaker the pier has a semi-circular section, with the batter of one-half inch to the foot. The down-stream ends are semi-circular in section, with the usual batter of one-half inch per foot. The other piers are smaller, 30.7 by 10.7 on top, but they are similar in shape. The foundation of the Virginia channel-pier consists of three courses of pine timber, one foot thick, decked over with 4-inch plank. All the other piers have under them four thicknesses of timber. The natural bed was excavated so that the lowest water would always cover this deck 1 foot deep. The stone is laid on this in courses 2 feet thick. The timber projects 1 foot beyond the masonry. The riprap protecting the timber platform extends out from 6 to 7 feet, and rises up from 1 to 4 feet above low water. The Virginia channel-pier stands in shoal water, and is well protected naturally, but the Ohio pier stands in the deepest water of the cross-section; and the river bottom abreast of the pier is on a level with the lowest timbers of its foundation. Nothing but the riprap that surrounds it saves it from destruction. It is proper to remark here, that none of the foundations are as deep as they should be, and most of the piers owe their stability entirely to riprap. One of the piers deflected 2 feet from the perpendicular while the bridge was being constructed, but a quick and liberal use of riprap prevented further inclination, and it is now probably as safe as the others. While we believe that ordinary floods will not imperil the safety of this structure, yet it is not impossible that an ice gorge at the bridge itself might, at some future day, do it great damage. The excuse alleged for the defective foundations of this bridge is the poverty of the company that originally began it. Unfortunately, these defects cannot be remedied excepting by outside protection, and that has been freely used. The bottom chord of the channel-span is 90 feet above low water, and 45 feet above highest water, the greatest known rise being 45 feet. This leaves a sufficient headway under the bridge at all stages, and there is no complaint against it on account of height. No record is kept of the daily stage of water at Steubenville.

The railroad track being on elevated ground on both sides of the river, there was no difficulty in making the approaches to this bridge, which consist of short and inexpensive embankments. In this respect it has a more advantageous site than any other railroad bridge over the Ohio.

This bridge has been a serious hinderance to navigation ever since it was built, and the causes are quite clear. The great variability in the river current, and the narrowness of the channel-span, which at most stages is oblique to the current, and therefore practically much lessened, are in themselves sufficient to account for the trouble heretofore experienced in passing this bridge. An official statement from the president of the Pittsburgh Coal Exchange of the losses, hitherto incurred by collision with the piers of this and other bridges over the Ohio River, is given in Appendix B. It will be seen that the actual loss by collision with the piers of this bridge from its construction to the present time amounts to $61,588. As navigators have really no remedy against the bridge companies, but must bear these losses themselves, it is manifest that, though the losses may sometimes be attributed to inexperience and lack of skill, they can never be considered as the result of design. It is unquestionable that bridges over the Ohio (though a public necessity) are a source of danger and loss to the navigation interest. Cases will sometimes arise where the best of skill will not avail, as in a recent accident at Bellaire, where the bridge was so obscured by the smoke of the rolling-mills on the banks that when the steamboat Star, with ten barges of coal came to the channel-span, the pilot was unable to see the piers and struck one of them; thereby losing his boat and barges, and the lives of two of the crew. Beside this, it is considered almost impossible to take fleets through these bridges at night; and as a rule they lay up for daylight, which, of course, increases the length and expense of the trip.

The Steubenville bridge is so very much the worst one on the river that a due regard for the right of the people to have the navigation of the Ohio not needlessly endangered requires that this bridge should be changed.

An examination of the map and profile of this bridge shows that the Virginia channel-pier stands in shoal water near the foot of the ferry bar, while the Ohio pier has deep water on both sides of it. If this alone were to determine the question the latter should be removed. Before coming to a decision on this matter numbers of prominent coal-boat pilots and owners were consulted, as the change was intended specially for their benefit, and they were unanimous in the request that the Ohio pier be moved, leaving the other where it is. Their principal reason, besides the one above mentioned was, that in coming out of the bend above at Wills Creek they are in the habit of keeping their fleets as near as possible to the Ohio shore for the double purpose of securing the shore as a guide to facilitate steering, and in order that there may be less danger of drifting into the bend on the Virginia side, below the bridge.

Under these circumstances the board of engineers are of the opinion that the channel-span of this bridge should be widened toward the Ohio shore.

In order to make the proposed changes at the least possible cost they have thought it best to utilize the present wide span, throwing out the second and third spans from the Ohio abutment, and introducing one new wide span. The two spans thrown out of 210 and 214 feet would not be wasted, as they are of dimensions that are frequently employed and could readily be sold or used elsewhere on the road. The first pier would require rebuilding, as the change would bring upon it a much greater weight than that which it now carries, and it would have to be raised to the height of the channel-pier in order to carry the present channel-truss, with an offset 22 feet lower for the first deck-span. In our estimate we give this pier the same dimensions as one of the present channel-piers, though it is probable that a less thickness would do as well. The second and third piers would necessarily be thrown out, being replaced by one nearly midway between them. The whole cost of making the change would then be the reconstruction of the first pier, and the building of a new channel-pier, the cost of one new span of 424 feet, and of the removal and re-erection of the present channel-span. This expense would be somewhat reduced by the value of the two spans that would be saved for use elsewhere. It would not be necessary to reconstruct the Virginia channel-pier. Instead of the present spans of 210, 210, 214, and 327 feet to the Virginia channel-pier, we would have 210, 327, and 424 feet, being three spans instead of four. The last-mentioned span would be the new channel-span, and it would give a clear opening at low water of 399 feet.

The cost of making this change would be as follows:

One new channel-span, 424 feet		$150,000 00
One new channel-pier:		
2,944.5 cubic yards masonry, at $18	$53,001 00	
368.5 cubic yards masonry, at $10	3,685 00	
		56,686 00
Preparing foundations		5,000 00
One new pier to replace No. 1:		
1,624.7 cubic yards masonry from old pier, at $10	16,247 00	
848.7 cubic yards masonry up to deck-span, at $15	12,730 50	
475.1 cubic yards masonry to finish, at $10	4,751 00	
		33,728 50
Preparing foundations		3,000 00
Removing and rebuilding present channel-span, and framing false-work		15,000 00
		263,414 50
Deduct for spans available elsewhere:		
One span 210 feet	$35,000 00	
One span 214 feet	35,000 00	
	70,000 00	
Subtract 10 per cent. for previous use	7,000 00	
		63,000 00
Total cost of changes		200,414 50

This estimate is somewhat larger than it would otherwise be, on account of the necessity of so conducting the changes as not to interfere with the traffic of the road. The method of making the changes indicated would probably be to replace pier No. 1 by a strong wooden pier straddling the present stone one, until the new and larger pier No. 1 is built up to the height of the present one, and truss No. 1 is seated on its new resting-place in an offset of the new pier. At the same time the new channel-pier could be built up to the same height. After this is done spans Nos. 2 and 3 and the channel-span could be replaced by trestle-work, while the new channel-pier is raised to its full height, the old channel-span removed, and the new channel-span is put in place. This might be done during low water in the summer, when coal-tows are not running. The work would probably require two seasons for its accomplishment. Some of the stones in piers 2 and 3 could be used in raising the new piers to their full height, but the greater portion of this material would be unavailable. It is possible that the new channel-span could be built outside of the present channel-span before its removal, and thus save filling the channel-space with false work; but this plan would not be altogether safe, and has not been considered in the estimate. After the work is finished the rest of piers 2 and 3 can be removed, and the material in them can be sold, or used elsewhere on the road.

The material will about pay the cost of taking down. The new piers should be parallel with the present ones.

As this bridge was built at a time when such long spans were deemed almost impracticable by Congress, and was itself a marked advancement in bridge-building, and as it seems to have been built in good faith, the board hesitate to recommend that the modifications be made at the expense of the bridge company, and regard it as a question for Congress to consider whether in ordering the change for the benefit of navigation, it would not be proper to bear at least a part, if not the whole, of the expense of making it.

Bridge-building is subject to so many contingencies that may increase or diminish the cost, that it is impossible to make an estimate that can be considered as rigidly correct. We would recommend that if the Government pays for this work, the bridge company, to whom it should be intrusted, be directed to keep an exact account of all expenditures, to be audited in the usual way. If the actual cost should exceed the appropriation, an additional appropriation can be made to cover it.

WHEELING AND BRIDGEPORT BRIDGES.

These are highway bridges owned by the Wheeling and Belmont Bridge Company, and they connect that portion of the city of Wheeling which is built on Wheeling Island with the city proper, and with Bridgeport, in Belmont County, Ohio. The suspension bridge was commenced in February, 1848, and opened to travel in November, 1849. On the 17th of May, 1854, it was destroyed by a hurricane. It was at once rebuilt out of the old material, with a single track, and in 1860 it was again rebuilt, with an additional amount of wire in the cables and new suspending-rods. The height of the bridge was not altered during these changes.

These two bridges were erected under authority from the State of Virginia. A violent opposition to the suspension bridge was at once manifested by the river interest, and suit was brought against the bridge company by the State of Pennsylvania on the ground that the bridge was an obstruction to navigation and an illegal structure. The proceedings and testimony in this case are reported at length in the report to the Supreme Court of Special Commissioner R. Hyde Walworth, to whom was intrusted the duty of reporting upon the case. This report was printed at Saratoga Springs in 1851 by George White, and reference is made to it for many interesting details, that we must necessarily omit. Pending the suit, an act of Congress was passed August 31, 1852, (see Appendix A,) legalizing the suspension bridge and the Bridgeport bridge as post-routes and lawful structures.

THE SUSPENSION BRIDGE.

This is a "high" bridge on the suspension plan, made for highway traffic only. The highest point of its under surface is 91½ feet above extreme low water, and 48 feet above highest water, the extreme oscillation of the river at this place being 43½ feet; for a width of 155 feet, it has a height of 91 feet above low water, and for a width of 235 feet a clear headway of 90 feet. It is proper to remark that these widths, and the grades on the bridge-floor, are taken from the levels made by our own surveying party, and that they differ slightly from the measurements as given in Chancellor Walworth's report to the Supreme Court. These discrepancies may be partly due to changes made when the bridge was rebuilt in 1854, and partly to the coldness of the weather at the time of our survey, whereby the suspension-cables were necessarily shortened, and the road-way elevated above its mean position. There is but one span to the bridge, the abutment on the eastern side being at the top of the high bank on which the city of Wheeling is built, and that on the other side being on the shore of the island, at the 12-foot line. The distance between the centers of the towers is 1,010 feet, and between the faces of the two abutments 980. The width of road-way is 16.4 feet, and each side-walk has a clear width of 4.2 feet, the entire width of the bridge, from out to out, being 28 feet. In low water the river does not occupy all the space between the abutments, and, consequently, the velocity at that time is not affected by the bridge. There are no spans between the towers and the two shores, as the eastern towers are on the natural surface, and a solid embankment, 341 feet in length, extends from the western towers to the natural surface of the island. The eastern towers are 15 by 15 at their bases, and 60 feet high above the road-way, making their tops 152½ feet above low water; they rest upon a single pier or abutment, which is built up to the height of the road-way, and they are connected on top by a masonry arch, 40 feet above the floor of the bridge. The western towers are 16 by 15 at their bases and 69¾ feet high, their tops being 131½ feet above low water; they are also built upon a single mass of masonry, and are similarly connected on top. The eastern abutment is founded upon the sand of the high bank upon which it is placed, and the western upon the river-gravel, a few feet above low-water mark. The bank under the eastern abutment is carefully paved with stone on edge, as also the shore of the island between the western abutment and low-water line.

In low water, as mentioned before, the bridge occupies no part of the water-way; in extreme high water the western abutment and the bridge approaches occupy 6,137 square feet, which is 14 per cent. of the entire high-water section at the bridge-site. The mean velocity of the river at this stage will not, however, be increased by this amount, as in extreme high water the entire width of the island between the two bridges is covered, and the water-way is ample.

The road-way at the face of the eastern abutment is 91.6 feet above low water. From this point the floor of the bridge rises with the following grades per 100 feet, viz, 2.56 for 50 feet, 2.54 for 50 feet, 2.06 for 50 feet, and 0.97 for 16½ feet, at which point it attains its highest elevation of 95.34 feet above low water, having risen 3.74 feet in a distance of 166½. From this point the road-way descends with the following grades per 100 feet: 1.58 for 33½ feet, 3.52 for 50 feet, 4.26 for 50 feet, 4.80 for 50 feet, 4.33 for 500 feet, 380 for 50 feet, and 3.55 for 84 feet, at which point it reaches the face of the western abutment, where the elevation of the road-way is 62 feet above low water, and 33⅓ feet below the highest point of the bridge. The length of descending grade is 817½ feet, measured on the floor.

The following tables are compiled from a record of from seventeen to twenty-one years, some of the months being missing in the earlier years. The record commences in 1840, is continuous to 1850, omits subsequent years to 1861, and thence is carried on to January 1, 1871, with some omissions during the period of the late war. The depths reported at Wheeling are those on the bar opposite the lower end of the city; at extreme low water there is one foot on this bar, and therefore the heights above low water are one foot less than those given in the table.

RIVER-RECORD AT WHEELING.

Average duration of each stage.

Months.	Height in feet on Wheeling Bar.							
	5.	10.	15.	20.	25.	30.	35.	40.
January	30.5	14.9	7.3	3.5	1.2	0.2	0.1	0.1
February	25.5	13.1	5.6	2.9	1.0	0.3	0.2	......
March	30.3	20.8	10.4	4.8	2.6	1.2	0.1	......
April	28.3	15.4	6.1	1.7	0.5	0.1	......	......
May	28.9	13.3	5.4	1.5	0.5	0.1	......	......
June	21.4	3.9	0.7	0.1	......	......	......	......
July	12.6	2.2	0.5	......	......	......	......	......
August	7.0	0.4	......	......	......	......	......	......
September	8.8	2.7	0.8	0.3	......	......	......	......
October	11.5	2.3	0.8	......	......	......	......	......
November	22.7	5.8	1.2	0.3	0.2	0.1	......	......
December	26.8	13.0	6.2	2.5	0.6	0.2	0.2	......
In each year	254.3	107.8	45.0	17.6	6.6	2.2	0.6	0.1
Headway under bridge	87½	82½	77½	72½	67½	62½	57½	52½
Headway available	86	81	76	71	66	61	56	51

Maximum duration of high stages.

Months.	20		25		30		35		40		High water of 1832.
	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	
January	12	1870	7	1870	3	1862	2	1862	1	1862	......
February	17	1840	9	1840	5	1840	3	1840	......	......	44½ feet.
March	15	1868	12	1868	7	1841	1	1835	......	......	......
April	12	1843	3	1843	1	1869	......	......	......	......	......
May	7	1838 and '40	3	1838	1	1838 and '49	......	......	......	......	......
June	2	1839	......	......	......	......	......	......	......	......	......
July	0	......	......	......	......	......	......	......	......	......	......
August	0	......	......	......	......	......	......	......	......	......	......
September	2	1868 and '69	......	......	......	......	......	......	......	......	......
October	1	1847	......	......	......	......	......	......	......	......	......
November	4	1847	2	1847	1	1847	......	......	......	......	......
December	9	1847	6	1847	4	1847	3	1847	......	......	......
Headway under bridge.	72½		67½		62½		57½		52½		48
Headway available.	71		66		61		56		51		46½

There have been no actual losses of boats at this bridge, though when first built, before steamboats had made arrangements to lower their chimneys, much damage, as well as loss by detention, was occasioned. This was entirely due to the efforts made to pass this bridge with chimneys standing, but since that has been given up, and boats on the upper river have been provided with hinged chimneys, there has been neither loss nor detention; we therefore have no changes to recommend in this bridge.

Its original cost was $161,594; the repairs on account of the hurricane of 1854 cost $37,000, and the partial reconstruction in 1860 cost $55,000.

THE BRIDGEPORT BRIDGE.

This bridge is over the western branch of the Ohio, which at Wheeling is divided by Wheeling (formerly Zane's) Island. It belongs to the same company as the suspension bridge, and was built under the same law of the State of Virginia and legalized by the same act of Congress. It is one of the common kind of wooden bridges, being a long truss strengthened by arches; it is in bad condition and needs rebuilding. This bridge is 638 feet in length and consists of three spans of about 212 feet each. Each span is composed of three trusses, with two roadways 10½ feet in the clear between them, and two balcony sidewalks, 5 feet wide on the outside.

The channel on the west of Wheeling Island is no longer used for navigation. In order to improve the draught of water on Wheeling Bar, the western channel has been closed by a 6-foot dam just below the mouth of Indian Wheeling Creek. Under these circumstances it was unnecessary to make any current observations or to examine this bridge in detail.

The bridge is 53 feet above low water and 9½ feet above highest water. Rafts and flats can at all times pass under, and no passage-way is required for steamboats.

Under these circumstances we have no changes to recommend in this bridge. Its original cost was $68,500.

BELLAIRE RAILROAD BRIDGE.

This is a single-track railway bridge and is being built by the Baltimore and Ohio Railroad Company under the general authority given by the act of July 14, 1862. It crosses the Ohio four miles below Wheeling, and connects the main stem of the Baltimore and Ohio Railroad with the Central Ohio. The bridge is a "high" bridge 4,001½ feet long, and that portion over the river consists of six spans of the following dimensions, beginning on the Ohio side, viz, 210, 241½, 348, 213, 212, and 211 feet, so that the bridge proper has a length of 1,435½ feet. These dimensions are from center to center of piers, and are in excess of the clear water-way. The trusses are of the Linville or Keystone pattern, the two longest being "through" or "over-grade" and the others "deck or under-grade." The two "through" spans are both channel-spans, giving clear openings at low water of 322 and 220 feet, respectively. It will be noted that in both the bridges built by the Baltimore and Ohio Railroad Company the span adjacent to the main-channel span (required by law to give an opening of at least 220 feet) is made a channel-span as well as the longest span. This was doubtless the intent of Congress in directing that one of the spans adjacent to the channel-span should give a 220-foot opening, but the act does not require the track to be on the bottom chord, and it is not so placed in either the Steubenville or Newport and Cincinnati bridge. Moreover in this bridge the law only requires a clear opening of 300 feet, while the company has voluntarily given 22 feet more. The bottom chords of the channel-spans are 91½ feet above low water, but the track being supported on roadway bearers suspended below the bottom chords, the lowest line of the channel-spans is 90 feet above low water and 40 feet above highest water. There is no daily record of the stage of water kept in Bellaire, but levelings from the highest known water-marks make the maximum oscillation of the river surface 50 feet. The two main channel-piers Nos. 3 and 4 are each 91 feet above low water; No. 2, the Ohio pier of the 220-foot channel, is 90 feet above, and the others are lower, conforming to the grades of the bridge. The foundation of pier No. 2 was laid by means of a coffer-dam, but the other river-piers were commenced in caissons, the bed of the river having first been dredged to the required depth. All of the piers in the river rest on grillages composed of three thicknesses of 12 by 12 oak timber; the grillages of the main-channel piers (3 and 4) are 78 by 28; of the others, 76 by 26. The top of the foundations of Nos. 3, 4, and 5 are 15 feet below low water, and of No. 2, 9 feet below, and of No. 6, 5 feet below. The depths at which these foundations have been placed contrast very favorably with the shallow foundations of the Steubenville and the Newport and Cincinnati bridges. There is no riprap at the low-water line about either of the main-channel piers.

The line of current approaching the channel-span from above, as indicated by 6-foot floats, makes, with the piers, an angle of 4°; it makes, with the perpendicular to the line of the bridge, an angle of 8½°, but the piers themselves, in order to conform to the line of the current, are set askew, and the trusses rest on two courses of stone, placed at an angle of 4½° with the piers, but at right angles to the axis of the bridge. By this arrangement the rights of navigation are preserved, without injury to the shape of the superstructure. It is believed, from the shape of the river above, that at higher stages the current will become exactly parallel to the bridge-piers, and we therefore conclude that the company has complied with the law, that the piers shall be parallel with the current. This point could only be determined positively by waiting for high water, but the time at our disposal did not permit such a delay; and as all our information tended to corroborate the statement given above, and as the details of the piers showed a manifest intention on the part of the company to comply with the law, we did not deem it necessary to investigate the matter further. The position chosen for the bridge is on a straight section of the river, where no great changes of current can occur.

The contraction of the channel-way due to a current making an angle of 8½° with the axis of the bridge is 8½ feet; and, therefore, at the observed stage, (8½ feet by the Wheeling marks,) the practicable opening at this bridge is 313⅓ feet, or 13⅓ feet more than required by the law. At most stages the reduction would probably be much less. We could make no observations on the current through the minor-channel span, as at the time of the survey this span was filled with scaffolding for the truss which was in process of erection, and a boom above deflected all floating bodies. The direction of the current through this space is probably the same as that through the principal channel opening.

The main-channel piers are 76 by 26 at the bottom where they rest upon the grillage, and are built up square to the low-water line; here there is an offset all around of 15 inches, and the piers are again carried up square to 4½ feet above low water. At this elevation their dimensions are 75½ by 23½. Above this the sides have the batter of one-half inch to the foot, the top of the piers terminating 5 feet below the bridge-seat with the dimensions of 41 by 16 feet.

The trusses rest upon a square prism of masonry 5 feet high, 26 by 14, placed at right angles to the axis of the bridge, and therefore making an angle of 4½° with the axis of the pier. The ice-breaker is a part of this pier, and commences 4½ feet above low water, with a slope of 1 on 1, and terminates 29½ feet above; it is built with steps of 2 feet rise and the same tread. These steps are to be filled with iron-angle blocks. Above the ice-breaker the up-stream end has a batter of one-half inch to the foot; the down-stream end has the same batter, commencing 4½ feet above low water. In horizontal section, both up and down stream ends are circular. The other piers in the river are similar to the main-channel piers, but they are somewhat smaller. The masonry, 74 by 24 at bottom, is 70 by 21 at the point where the batter commences, and 33 by 12 on top.

The grades and curvature on the bridge and approaches are as follows, commencing on the Ohio side:

Distance.	Grade in ft. per mile.	Curvature.	Remarks.	Distance.	Grade in ft. per mile.	Curvature.	Remarks.
830	52.8	5°	Arcade.	546.5	44.5	Tangent ..	
660	52.8	Tangent ..	Do.	953.5	44.5	5°	
423	26.4	....do					
589.5	0.	....do	Channel spans.	4,001.5	....	....	

The approaches on the Ohio side consist of 43 semicircular stone arches, 33⅓ feet from center to center, (the entire length being 1,490 feet,) and two spans of Bollman deck-bridge, 105 and 107 feet long, respectively. This approach is very massive and imposing, and reflects great credit upon the company, being as safe and as durable as a track on solid ground, and permitting any rate of speed with safety. The piers of the arches are 10⅔ by 5⅔, the clear span of each arch being 28 feet. The arcade is 12 feet wide on top, being designed for a single track. The piers of the arcade are all founded on three feet of concrete, laid at various depths, from 8 to 26 feet below the natural surface. The two shore-piers between the end of the arcade and the bridge proper are 22 by 10 on top, also resting on three feet of concrete, placed at depths of 20 and 6 feet, respectively, above low water.

The approaches on the Benwood, or Virginia, side consist of eight Bollman deck-trusses, each with a span of 108 feet, making a total length of 864 feet. The piers for these trusses have the same general dimensions as the shore-piers on the Ohio side, and their foundations are from 10 to 30 feet below the natural surface. The arcade on the Ohio side was nearly finished at the time of our inspection, but very little had been done on the Virginia side. The bridge will probably be finished during the coming summer.

At the time of the surveys the water stood at 8.5 by the marks at Wheeling. At this time the section of the river at a point 800 feet above the bridge was 11,105 square feet, and the discharge was 36,261 cubic feet per second, showing an average velocity of 3.265 per second or 2,226 miles per hour. The floats through the channel-span had a velocity of 3.1 miles per hour. The actual water-way on the line of the bridge at the date of the survey was 10,532 square feet, which being 5 per cent. less than the natural section above, showed that the average velocity of the water must be increased 5 per cent. on account of the space occupied by the piers. The total high-water section at the bridge-site is 74,787 square feet, of which 6,735 square feet, or 9 per cent., is occupied by the bridge-piers, and this would probably cause an increase in the mean velocity at that stage of the same amount. The low-water section is 3,425 square feet, of which 506 square feet, or 15 per cent., is obstructed. This, however, would make no material difference, as the bridge is built in a pool. No regular record of the rise and fall of the river having been kept at this locality, the duration of the various stages can only be ascertained approximately by an examination of the record at Wheeling, which is only four miles above. It should be kept in mind, however, that the maximum oscillation at Bellaire is reported at 50 feet, while at Wheeling it is 43½.

The losses at this bridge up to date, as given in the statement of John F. Dravo, president of the Coal Exchange, (Appendix B,) amount to $60,500. Some of these were due to causes connected with the process of construction that will not be permanent.

The greatest objection to the location of this bridge is the proximity of extensive rolling-mills on both sides of the river. The smoke from these mills frequently lies so low that navigation even without a bridge is made difficult. This is a cause, however, that admits of no remedy unless a law should be made to compel factories to consume their smoke, of which there seems no present likelihood. The accident to the tow-boat Star, referred to in connection with the Steubenville bridge, is an illustration of the incidental dangers of navigating the Upper Ohio. The board have not only no changes to recommend in this bridge, but they feel called upon to commend both the excellent manner in which it is constructed and the liberality with which the company has secured to navigation, at considerably extra expense, more than they were required by law to give. We have not been able to ascertain what will be the cost of this bridge when finished; but it will probably be the most expensive work of the kind on the river. The money, however, will have been wisely expended.

PARKERSBURGH BRIDGE.

This is a single-track railway bridge, belonging to the Baltimore and Ohio Railroad Company, and it is designed to connect their Parkersburgh branch with the Marietta and Cincinnati Railroad. It has just been finished, having been opened to travel in February last. It has been constructed under the general authority to build bridges above the mouth of the Big Sandy which is given by the act of July 14, 1862, (Appendix A,) under which the Steubenville and Bellaire bridges are built. It is a "high" bridge, with a total length between abutments of 4,262 feet. That portion over the river consists of six spans of the following dimensions, commenced from the north or Belpre side, viz, 210, 350, 350, 210, 210, 210, making a total length over the river proper of 1,540 feet. These dimensions are from center to center of piers, and must be reduced by the widths of the piers to get the clear water-way. These trusses are of the Linville or Keystone pattern, the two longest being "through" or "over-grade" bridges, and the other "deck" or "under-grade." The two high spans are both channel-spans, and give clear openings at low water, measured on the axis of the bridge, of 326½ feet. The bottom chords of the channel-spans are 91½ feet above low water, but the track being supported by road-way bearers suspended below the bottom chords as in the Bellaire bridge, the lowest line of the channel-spans is 90 feet above low water, and forty feet above highest water. There is no daily record kept here of the stages of the river, but the greatest known oscillation is reported to be 50 feet. The tops of all the piers in the river, excepting the first one on the Ohio side, are 91 feet above low water; the latter is somewhat lower, conforming to the grade of the bridge. The foundations of piers 1 and 7 are 3 feet below low water; of 2, 3, 4, and 5, 20 feet below; and that of No. 6, 18 feet below. No. 1 has its foundation 16 feet below the natural surface; No. 2, 21 feet; No. 3, 12 feet; No. 4, 9 feet; No. 5, 15 feet; No. 6, 20 feet; and No. 7, 40 feet. All of these piers are built upon grillages composed of three courses of 12 by 12 white-oak timber, projecting on all sides two feet beyond the masonry. Piers 2 and 6 are reported to rest on the rock. The foundations of all the river-piers were put in place by means of coffer-dams, the lower portions of which were made solid with 12 by 12 timbers up to 5 feet below the low-water line. This part of the work was begun in May, 1869, and completed before the close of the season. There will be no riprap at the low-water line about any of the river-piers. Their foundations are laid so deep that but little protection will be necessary, and what is used will be below low water, and thus the entire channel-way will be available for navigation.

This bridge being located in a bend, the currents are naturally curved, varying somewhat with the different stages of the river. No floats could be sent through the northern channel-span, as at the time of observations it was obstructed by a boom and trestle-work. Under these circumstances the most accurate method of determining the angle between the piers and the current was to find the normal to the curves of the current, and then the angle between this normal and the line of the bridge. The angle thus determined was found to be 5° 30″, and this, therefore, is the angle between the axis of the piers and the line of the current. The contraction of the available width by this obliquity is 8½ feet, thus leaving two practicable channel-ways of 318 feet each. As the law only required one channel-space of 300 feet, the bridge campany are deserving of very great credit in not only providing two channel-spans instead of one, but in making each 18 feet wider than required by law for the widest. We are credibly informed that it was the original intention of the company to have built this bridge exactly like that at Bellaire, but after they had started the piers of their main-channel span a protest was made against this span by the coal-boat interest. The latter claimed that although the main span was over the deepest water of the river, it was yet not over the coal-boat channel, as the very abrupt bend in the Ohio, just below the bridge, made it necessary for coal-tows to hug the Ohio shore, that they might not drift on to the Virginia shore after passing the bridge. An estimate was made of the cost of making an additional channel-span near the Ohio shore, and it was found that it would increase the cost of the bridge by $60,000.

The railroad company very liberally offered to bear half of this additional expense, provided the coal-men furnished the other half. The latter decided that unless they obtained a new channel-span, they might in a single year lose more by collision, or by running ashore, than the sum required, and therefore the money was advanced at once. A full statement of the amount paid by each subscriber is given in Appendix C, certified to by the president of the Coal Exchange. This is one of those special cases showing how important it is that the positions of bridge-piers should be carefully decided upon by some disinterested authority before they are commenced. The whole course of the railroad company forbids the supposition that they designed unnecessarily embarrassing navigation, and yet a serious obstruction would have been caused but for the expenditure of a large sum by the principal tow-boat owners.

Piers 2, 3, and 4 are 82 by 28 feet at bottom, where they rest on the timber foundations. They are carried up to low-water line with vertical offsets, and at that elevation they measure 75 by 24 feet. From low water the sides are carried up to the bridge seat with the batter of one-half inch to the foot. On the up-stream ends the ice-breakers are formed like those at Bellaire, with two-foot offsets on a slope of 45° to the height of 26 feet. Above them the up-stream end is built up with the same batter as the sides, to within 4 feet of the top, where there are two two-foot offsets. The down-stream ends have the usual batter, with similar offsets at top. The dimensions of the channel-piers on top are

33 by 16 feet. The other river-piers are similar in construction to the channel-piers but smaller. They are 60 by 23½ at bottom, and 33 by 12 on top.

The grades and curvatures on this bridge and its approaches are as follows, commencing at the face of the abutment on the Ohio or northern shore:

Distance.	Grade in ft. per mile.	Curvature.	Remarks.	Distance.	Grade in ft. per mile.	Curvature.	Remarks.
202	52.8	Tangent.	Ohio approach.	53	0.	4° 20″	Main bridge.
520	52.8	4° 20″		600	39.6	4° 20″	Virginia approach
210	52.8	Tangent.	Main bridge.	1,390	39.6	Tangent	
1,287	0	Tangent.		4,262			

The approaches on the Ohio side, commencing from the abutment and not including a long and high embankment, consist of six spans of Bollman deck-trusses, each span being 121 feet, making a total length of 726 feet. The trusses rest on piers whose dimensions on top are 21 by 7 and 24 by 7. They have the usual batter, and are founded upon three feet of concrete, at depths below the natural surface varying from 6 to 8 feet.

The approaches on the Virginia side consist of a great number of spans, some of which are both short and low—the authorities of Parkersburgh having objected to the construction of masonry arches. Commencing at the Virginia abutment they are as follows: seven spans of girder bridge, each 25 feet long; 4 spans of girder bridge, each 29 feet long; one through-bridge of 65 feet span over Market street; six Bollman deck-bridges, each 59 feet long; one Bollman deck-bridge of 65 feet span, over Julian street; six Bollman deck-bridges, each 59 feet long; one Bollman-deck bridge, of 65 feet span, over Ann street, and eight Bollman deck-bridges, each 100 feet long, up to the first span over the river. The total length of the Virginia approach from the abutment is 1,994 feet. The piers for this approach vary in size on top from 10 by 4 to 18 by 8 feet. They are built with the usual batter, and the seven nearest the bridge proper rest on foundations of 3 feet of concrete, laid at depths of from 7 to 25 feet below the natural surface.

At the time of the surveys the water stood at 8 feet by the gauge of the Baltimore and Ohio Railroad at Parkersburgh. At this time the section of the river, at a point 900 feet above the bridge, was 15,676 square feet, and the discharge was 41,058 cubic feet per second, showing a mean velocity of 2.619 feet per second, or one and three-fourths miles per hour. The floats through the channel-span showed a velocity of 2.4 miles per hour. The actual water-way on the line of the bridge, at the date of the survey, was 13,749 square feet, which, being 12 per cent. less than the natural section above, showed that the average velocity of the water must be that much increased by the piers; it should be remarked, however, that the coffer-dams had not yet been removed, and the water-way was more obstructed than it will be in future. The total high-water section at the bridge site is 114,854 square feet, of which 11,177 square feet, or 10 per cent., is occupied by the bridge-piers, and this would probably cause an increase in the mean velocity at that stage of the same amount. The low-water section is 7,271 square feet, of which 608 square feet, or 8 per cent., is obstructed. This, however, would cause no injurious effect.

The losses at this bridge up to date, as reported in Appendix B, amount to $45,900. As the pilots become more familiar with the bridge these losses will probably nearly cease. That they should altogether cease is improbable, as winds, smoke, fogs, and accidents to machinery will still combine to occasionally cause collisions, which, however, must be considered as the irremediable dangers that will always attend river navigation.

The board have no changes to recommend in this bridge, which, like the one at Bellaire, has been admirably built, and with the most liberal care for the interest of navigation. It is a possibility that in the future it will be found that the main spans of these bridges are too narrow. Should that prove to be the case, we think that any changes that may subsequently become necessary should be made at the national expense.

The total cost of this bridge, as reported by the chief engineer, James L. Randolph, has been $1,223,550.

NEWPORT AND CINCINNATI BRIDGE.

This is a combined railroad and highway bridge, crossing the Ohio River about one mile above the Covington and Cincinnati suspension bridge, and connecting the cities of Newport, in Kentucky, and Cincinnati, in Ohio. It belongs to a bridge company, and is being constructed under the authority of the joint resolution of March 3, 1869, (Appendix A,) which is supplementary to the act of July 14, 1862.

This bridge was in process of construction as a "low" bridge, with a draw 70 feet above low water, but the Forty-first Congress, in its third session, ordered that the bridge be raised to 100 feet above low water, as recommended in our report to the Chief of Engineers dated December 21, 1870, which has been printed as Executive Document No. 22, of the third session of Forty-first Congress. For a detailed description of this bridge and of the changes recommended, reference is made to that document, which, corrected for typographical errors, is submitted again (see Appendix D) as a part of this report.

In recommending that this bridge be raised, and in estimating the cost of doing so, we did not feel at liberty to change its alignment, though there was no reason why the company should not do so, if they thought best. The change has been so recently ordered that it is yet uncertain what changes in the location of the approaches may be adopted, and therefore we have nothing to add to our previous report. Any modification of the Cincinnati approach, however, is an unimportant matter to navigation, as probably no change will be made in that portion of the bridge which spans the river. The losses by collision with the piers and coffer-dams of this bridge amount to $4,000. (Appendix B.)

COVINGTON AND CINCINNATI SUSPENSION BRIDGE.

This is a highway bridge, owned by the Covington and Cincinnati Bridge Company, and connecting the city of Covington, in Kentucky, with the city of Cincinnati, in Ohio. It was commenced in 1856, and the two piers were raised to the level of high water. The financial crisis of 1857 caused a stoppage of the work, and it was not resumed until 1863. From that time forward the work of construction progressed rapidly, and the bridge was finally opened to travel on the 1st of January, 1867, eleven years after the foundations were begun. It is a magnificent structure, and one of which the citizens of the two cities are justly proud.

This was the second bridge actually begun over the Ohio River, and it will be instructive to indicate the course of legislation in regard to its height and span.

The first charter was granted by the State of Kentucky, in February, 1846, with no restrictions as to height or span, but a proviso prohibiting the erection of any bridge "which may obstruct the free and common navigation of the said river Ohio." This charter was confirmed by the State of Ohio in March, 1849, with the additional proviso "that the said bridge shall not be of less span than 1,400 feet, nor of less elevation at the center of the river than 112 feet above low-water mark." In March, 1856, the charter of the bridge company was amended by the State of Ohio so as to permit a span of 1,000 feet, but the height at the center was increased to 122 feet. In January, 1863, the State of Kentucky authorized a reduction of height at the center to 100 feet above low water, and in March, 1863, the State of Ohio concurred in this reduction. In March, 1865, the State of Ohio passed a general act authorizing the construction of bridges over the Ohio River, *Provided*, "That the span of any such bridge be not less than the Ohio River at the point where the same is located, at low-water mark, and the height of any such bridge in the center shall not be less than 100 feet above the surface of the water at low-water mark."

The Covington and Cincinnati bridge was declared by act of Congress approved February 17, 1865, (Appendix A,) to be a lawful structure when completed in accordance with the laws of the States of Ohio and Kentucky.

This bridge comes under the class of "high" bridges with continuous spans. It is built on the suspension plan, being supported by two large wire cables, strengthened by stays, and stiffened by iron girders and trusses. For a full description of the details, most of which must necessarily be omitted here, reference is made to the report of John A. Roebling, the engineer-in-chief, dated April 1, 1867. The roadway is 20 feet wide, with two side-walks outside of the cables 7 feet in width, making the total width of the bridge 36 feet. Between the abutments, the entire length of the bridge is 1,619 feet. The highest point of its under-surface is at the middle of the bridge, and at the time of our survey it was $103\frac{1}{3}$ feet above low water, and $40\frac{5}{6}$ feet above highest water. These distances correspond to a mean temperature of 60°, and they are increased or diminished one foot by the cold of winter or the heat of summer. At this mean temperature, it has a clear headway of 100 feet above low water for a width of about 450 feet in the middle. The bridge consists of one main span and two half spans on either side. The southern side of the Cincinnati pier is located 35 feet north of the low-water mark, and the center of the Covington pier is 1,057 feet south of the center of the Cincinnati pier, with its river side 30 feet south of the low-water mark, there being between them a clear opening of 1,005 feet. The river side of the base of the Cincinnati pier is 18.8 feet above low water, and of the Covington pier 17.1 above. The width of the river between the piers at dead low water is 940 feet. Both piers being thus out of water at low water, the velocity at this stage is not affected by the bridge. The side spans have each a clear width of 255 feet between abutments and piers. The bridge approaches commence at Front street in Cincinnati, gradually rising on a mass of masonry 160 feet in length, to Water street, (66 feet wide,) which is crossed by a bridge of plate girders strengthened by wire-rope hog-chains. Between Water street and the wharf, a distance of 104 feet, the roadway rests on a solid mass of masonry, which also serves as an anchorage for the cables. Then come in succession the Cincinnati half span, the main span, and the Covington half span to the Covington abutment. From this abutment to Second street is a mass of masonry, which also serves as the anchorage for the cables on the Kentucky side. The distance between the face of this abutment and Second street is 300 feet. On the Cincinnati side the foot of the approach on Front street is 2½ feet below extreme high water, but on Second street in Covington it is 8½ feet above.

Each pier is 82 by 52 feet at the base, and rises to the height of 91½ feet above low water in one mass, solid under the towers, but hollow between them. Above this level begin the separate towers for the two cables, which are united near the top by a masonry arch, whose crown is 75 feet above the floor, with a span of 30 feet over the opening between the towers for the roadway. Including the ornamental turrets on top, the heights of the towers are 230 feet above low water, and 167½ feet above high water of 1832, the greatest flood known on the Upper Ohio.

The foundations of the Cincinnati pier rest on a bed of compact gravel 12 feet below extreme low water. The rock bottom of the river was found to be 12 feet lower, but it was deemed unnecessary to excavate to that depth.

The foundations consisted of twelve courses on the river side, and eight courses on the land side of 12 by 12 timber, well bolted together, breaking joints, with the alternate layers at right angles. Interstices were filled with gravel and broken stone well grouted with cement. The timbers were from 25 to 40 feet in length, and the platform was 110 feet long by 75 feet wide. In each pier there is 400,000 cubic feet of masonry, and the weight on each square foot of the foundations, including the weights of the superstructure and of the loads, is 3.88 tons. The foundation of the Covington pier is laid on a stratum of mixed sand and gravel 6 feet below low-water mark, the solid rock being 11 feet deeper. Seven courses of timber were laid in this pit in the same manner as on the Cincinnati side, and on the platform thus formed the pier was built. Between each pier and the low-water mark, the surface was protected by a sloping riprap. This, however, does not obstruct the channel, as it is on the same slope as the wharves. Special care was given to the Covington riprap, which was bound together by a strong crib-work with a sunken flat-boat at its foot.

The river at the site of the bridge has a width at low water of 940 feet, and a cross-section of 6,526 square feet. At 6 feet above low water (the stage at the time of the survey) it had a width of 950 feet, and a cross-section of 11,940 square feet. At both of these stages the piers were out of water, and the river was entirely unobstructed. At a stage of 18.8 feet, the water reaches the nearest side of the Cincinnati pier, and at 17.1 feet the nearest side of the Covington pier. At extreme high water the section is 80,475 square feet, of which 5,500, or 6½ per cent., is obstructed by the piers. The mean velocity at that stage would therefore be increased in this proportion by the bridge. The grades on the bridge and its approaches vary somewhat on account of its arched shape. The heaviest grade is on the half spans, being 5.36 per 100, or 1 in 18⅝, for a distance of 280 feet. On the main span the grades are much less.

The following tables of the stage of water during the last twelve years have been compiled from the official records kept at the Cincinnati waterworks. The first table is the same as that heretofore published in our special report on the Newport and Cincinnati bridge, excepting that the headway refers to the suspension bridge. The other table, showing the longest duration of the higher stages, is compiled from the same records, and has been added to supply a deficiency that was felt during the debate on the alteration of the Newport bridge.

RIVER RECORD AT CINCINNATI.

Average duration of each stage.

Months.	Height in feet above low water.										
	5.	10.	15.	20.	25.	30.	35.	40.	45.	50.	55.
January	31.0	30.5	25.0	19.7	13.0	8.3	6.5	2.7	1.8	1.2	0.4
February	28.0	27.5	25.0	18.2	12.8	9.0	8.8	3.2	1.2	0.2	......
March	31.0	31.0	29.3	27.0	21.6	14.7	10.5	5.4	3.5	1.8	0.8
April	30.0	30.0	29.0	26.6	18.2	11.8	8.3	4.5	2.1	0.1	0.1
May	31.0	30.1	22.8	14.0	8.0	5.5	3.3	1.2	0.8	0.3	0.2
June	29.5	23.2	11.8	4.7	2.3	1.5	1.0	0.3	......	......	......
July	29.6	12.1	4.6	1.4	0.4	......	......	......	......	......	......
August	26.6	7.8	1.9	......	......	......	......	......	......	......	......
September	19.9	10.1	5.9	2.3	1.3	1.2	0.6	0.3	......	......	......
October	22.0	9.1	4.8	2.4	1.3	0.7	......	......	......	......	......
November	17.0	15.1	10.1	5.9	2.7	0.6	0.3	0.2	......	......	......
December	30.3	26.3	21.3	10.2	8.8	5.3	2.3	0.8	0.1	......	......
In each year	325.9	252.8	191.5	132.4	90.4	58.6	41.6	18.6	9.5	3.6	1.5
Headway under bridge	98	93	88	83	78	73	68	63	58	53	48
Headway available	96½	91½	86½	81½	76½	71½	66½	61½	56½	51½	46½

Maximum duration of high stages.

Months.	20		25		30		35		40		45		50		55		High water of 1832.
	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	*Feet.*
January	31	1870	29	1870	16	1870	14	1870	10	1862 1870	9	1870	6	1862 1870	4	1862	
February	26	1867	26	1867	21	1862 1867	18	1862 1867	15	1867	13	1867	7	1859 1867	2	1859	62½
March	31	1859 1862 1863 1865 1867 1870	31	1859 1862 1865 1867	29	1865	23	1865	19	1865 1867	14	1867	12	1867	3	1867	
April	30	1862 1867 1869 1870	23	1865 1870	21	1862	17	1862	15	1862	8	1870	1	1859	1	1859	
May	26	1865	22	1865	17	1865	13	1865	8	1865	6	1865	2	1859 1865	2	1859	
June	22	1858	20	1858	19	1858	13	1858	4	1856							
July	15	1869	5	1859													
August																	
September	13	1868	10	1866	7	1866	4	1866 1868	2	1866 1868							
October	14	1861	10	1861	5	1861											
November	20	1864	11	1864	7	1861	4	1861	2	1861							
December	28	1866	21	1858	9	1865	5	1864	1	1864							
Headway under bridge	83		78		73		68		63		58		53		48		40½
Headway available	81½		76½		71½		66½		61½		56½		51½		46½		39

No losses have ever been reported as caused by this bridge, and we have no changes to recommend. The original cost of the bridge, without including real estate or anything not directly chargeable to the construction account, was $1,480,000.

LOUISVILLE BRIDGE.

This bridge, sometimes known as the Ohio Falls bridge, is a railroad and foot bridge, and it crosses the Ohio at the head of the falls, extending from a point just below the city of Jeffersonville, in Indiana, to the foot of Fourteenth street, in the city of Louisville. It belongs to a special bridge corporation, and serves to connect the Indiana railway system with the roads on the south of the Ohio that center at Louisville.

The bridge company was chartered by the State of Kentucky, with authority to construct a bridge that should not obstruct the navigation of the Ohio, "further than the laws of the United States and the decisions of the Supreme Court shall hold to be legal." Their authority from the United States is derived from the act of Congress approved February 17, 1865, which is supplementary to the act of July 14, 1862, under which the Steubenville, Bellaire, and Parkersburgh bridges are built. Under these acts the company were authorized to build any one of the three following styles of bridge, viz:

1. Continuous 90 feet above low water.
2. With a draw 70 feet above low water.
3. With three draws 56 feet above low water.

The location of this bridge is peculiar, and the provisions of the act of 1862 do not apply very well. The authority to build under that act might have caused a great deal of injury to navigation, had its provisions been interpreted to the letter. At the Falls of the Ohio there are really three navigable channels to be crossed—the Indiana Chute, the Middle Chute, and the canal. As the act in question only contemplated one channel, an illiberal interpretation might have resulted in seriously affecting navigation through the others. Fortunately the company met the difficulties of the case in a most commendable public spirit, and they not only adopted the highest of the three bridges, but they largely increased the channel-ways that they were required to give.

This bridge, as built, belongs to the class of "high" bridges, as distinguished from bridges with draws, and an elevation of but 70 feet. It has a single railroad track, and two sidewalks, each 7.2 feet wide, and its total length between abutments is 5,218⅔ feet. The spans commencing at the abutment on the Indiana or north shore are as follows: 99, 149.6, 180, 180, 180, 398¾, (Indiana Chute,) 245½, 245½, 245½, 245½, 245½, 245½, 370, (Middle Chute,) 227, 227, 210, 210, 180, 180, 149.58, 149.58, 149.58, 149.58, 132, 132, (draw over canal,) 50, 50. These dimensions are from center to center of piers, and they are greater by the half widths of two piers than the clear water-way. The trusses themselves are of the two styles patented by Mr. Albert Fink, the chief engineer of the bridge. The two channel-spaces are spanned by Fink triangular trusses, and all the others except the draw by Fink trussed girders. The draw-bridge is what is generally known as a Warren girder, differing only from the triangular, in that the latter has certain additional members that are necessary to adapt it to long spans. The former are "through" or "over-grade" bridges, and the latter "deck" or "undergrade." The clear waterway at the Indiana Chute, measured on the low-water line, is 380 feet, and at the Middle Chute 352¼ feet. The roadway bearers of the channel-spans are suspended below the bottom chords, and consequently the height under the bridge available for steamboats must be measured to these members. The line of the roadway bearers of the Indiana channel-span is 96½ feet above low water, and 45½ feet above highest water, the maximum oscillation being 51 feet. At the middle channel-space the river is dry at low water, and the available space above the river-bed is 90 feet. These two channel-spans are on the same level, but at the Indiana channel the break in the rocky ledge is 1,000 feet above, while at the middle channel it is 6,000 feet below. The line of the crest of the falls is exceedingly irregular, crossing the line of the bridge between the the two channel-spans nearly at right angles.

The tops of the four channel-piers and of all piers between them are 97¼ above low water of the Indiana Chute. The others are lower, conforming to the grades of the bridge.

The foundations of all the piers of this bridge were laid on the solid rock, and therefore there is no need of any riprap protection around them.

Current observations were made by the surveying party, but they were of little practical value. The water was too low to permit boats to cross the falls, and therefore it was of no importance to ascertain the angles between the current at this stage and the piers. As the river rises, the effect of the falls becomes gradually less perceptible, and the currents become more and more regular, until in high water the falls entirely disappear. We have good reasons for believing that the bridge is as nearly as possible at right angles to the current at navigable stages, and therefore did not think it worth while to incur the expense of a special survey at high water.

The right pier of the Indiana channel-space is 64 feet 6 inches by 17 feet 10½ inches at bottom; thence it is carried up vertically with 10½ inches of offsets, to 10 feet above low water. Above this the sides have the uniform batter up to the coping of $\frac{7}{16}$ of an inch per foot. The left pier is 65 feet 6 inches by 18 feet 8 inches at bottom, and is carried up vertically with 1 foot 6¼ inches of offsets to 18 feet above low water. Above this the sides have the usual batter. The up and the down stream ends of the piers are built alike, with starlings formed by the intersection of arcs of circles with radii of 12½ feet. They are capped by hoods at high-water mark, and above this are finished with semicircular sections. These piers, on top, (without coping,) measure 33 by 10. The piers of the middle channel are 64 by 17¾ feet at bottom, and 33 by 10 feet on top, with starlings and hoods like the other channel-piers.

The other piers are similarly constructed, excepting that above the lower starlings and hoods they have another starling and hood, which makes a shorter length of pier on top. The top dimensions of pier No. 7 (without coping) are 21 by 7, the dimensions at bottom being 45⅝ by 14½.

The grades and curvatures on this bridge and its approaches are as follows, commencing at the face of the abutment on the Indiana or northern shore:

Distances.	Grade.	Curvature.	Remarks.
785.1	78.6	Tangent	Indiana side.
2,241.75	0	Tangent	Channel-spans and spans between.
2,192.82	79.11	Tangent	Kentucky side.
5,219.67			

The approach to this bridge on the Indiana shore consists of a long and high embankment. This, however, does not properly belong to the bridge, and in accordance with the rule adopted for other bridges we consider that we have reached the end of a bridge when we come to earth-work Under this rule this bridge has no approaches, the entire space from abutment to abutment being water-way.

This bridge crosses the Louisville and Portland Canal 1,700 feet below the guard-lock at the head. An unobstructed passage-way for steamboats is secured by means of a draw, giving a clear opening of 114 feet over the canal. The other end of the draw projects over a portion of the river, and by modifying the canal-bank on this side so that it shall just have the width of the pivot of the draw it will be practicable for steamboats in high water to ascend the river without lowering their chimneys. This is a very valuable provision for boats that habitually run where there are no bridges, which yet may occasionally wish to go above Louisville. In low water such boats can pass through the canal, and in high water, by using the other end of the same draw, they can pass up the river even should they be too wide to get through the new locks. The changes in the canal bank necessary to permit this use of the northern end of the draw are being made by the United States as a necessary adjunct to the enlargement of the canal.

The total high-water section of the river on the line of the bridge is 216,249 square feet, of which 13,573 square feet, or 6 per cent., is occupied by the piers. This contraction would probably cause no perceptible increase of velocity. The low-water section is 1,377 square feet, of which 60 square feet, or 4½ per cent., is obstructed. All the water at this stage is running through the Indiana Chute, but there being no navigation possible the effect of the piers need not be considered.

The losses by collision with the piers of this bridge up to date amount to $26,704. (Appendix B.)

The board have no changes to recommend in this bridge, which they consider a first-class structure throughout, and very much less an obstruction than it might have been had its builders limited themselves to giving only what they were compelled by law to give. On the contrary they have chosen to build according to the highest of the three authorized plans, and have exceeded the heights and widths that even this plan required, spending $150,000 more than was necessary to comply with the letter of the law. Instead of a 300-foot opening at low water, one of their channel-spans gives 380 feet, and the other 352½ feet. The total cost of the bridge, from abutment to abutment, was $1,615,120.

If it should be found by experience that owing to the peculiar location of this bridge the channel space on the Indiana side cannot be safely run by coal-tows, then a still wider opening will be necessary. Present difficulties, however, may possibly be due to a lack of experience; should it be found, however, that there are inevitable dangers due to this exceptional location which no amount of experience can avoid, it will be manifestly necessary to widen this span to 500 feet, or in some manner to modify existing conditions so as to facilitate the passage of the present opening.

The record of the average and the extreme stages of the river for the years 1851, 1858, 1859, 1866, 1867, 1868, 1869, and 1870, is given in the following tables for the head and the foot of the falls. No other records of the stage of water on the falls could be obtained. As the main channel opening of the bridge is located below the head and above the foot of the falls, the exact space under the bridge cannot be obtained from these tables, and has therefore been omitted. At the head of the falls the heights above low water are also the available depths for navigation, as during extreme low water the rocks in the channel are bare.

RIVER RECORD AT HEAD OF FALLS.

Average duration of each stage.

Months.	Height in feet above low water.							
	5	8	10	15	20	25	30	35
January	20.6	8.5	5.5	2.2	1.2	1.1	0.5	
February	18.9	7.7	5.7	3.1	2.7	2.5	1.1	
March	29.1	15.0	10.1	5.5	3.0	1.7	1.1	0.4
April	26.5	10.7	8.1	3.4	1.6			
May	19.1	6.0	4.0	1.0	0.6	0.4		
June	10.4	2.7	2.1	0.9				
July	3.0							
August	0.1							
September	4.1	1.7	1.0	0.4				
October	2.1	0.6	0.3					
November	2.7							
December	17.4	6.0	2.4	0.9				
In each year	154.0	58.9	39.2	17.4	9.1	5.7	2.7	0.4

Maximum duration of high stages.

Months.	20.		25.		30.		35.		High water of 1832.
	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	
January	10	1870	9	1870	4	1870			
February	13	1867	12	1867	5	1859			41.5 feet.
March	20	1867	14	1867	9	1867	3	1867	
April	6	1870							
May	5	1859	3	1859					
June									
July									
August									
September									
October									
November									
December									

RIVER RECORD AT FOOT OF FALLS.

Average duration of each stage.

Months.	Height in feet above low water.												
	5	8	10	15	20	25	30	35	40	45	50	55	60
January	31.0	31.0	29.1	24.0	18.1	12.0	7.4	5.0	2.7	1.7	1.3	0.7	
February	28.0	28.0	22.4	18.4	13.4	9.7	6.3	4.9	3.4	3.1	2.9	1.9	
March	31.0	31.0	31.0	28.7	25.4	18.8	14.3	8.7	6.0	3.6	2.6	1.4	0.7
April	30.0	30.0	29.9	28.4	25.6	17.4	11.0	7.0	4.0	2.4	0.3		
May	31.0	30.3	26.9	20.6	13.6	9.4	7.6	3.6	1.1	0.7	0.6		
June	30.0	26.6	22.9	11.6	6.4	4.3	3.1	2.0	1.0				
July	29.3	12.3	6.9	4.3	1.6								
August	23.9	7.3	4.4	0.3									
September	18.1	9.4	7.9	4.9	3.4	2.1	1.8	1.0	0.4				
October	17.3	6.6	5.1	2.6	1.6	1.0	0.7	0.3					
November	20.4	9.6	8.4	3.3	1.6								
December	29.3	27.0	24.1	19.3	12.4	8.0	4.9	1.7	0.9				
In each year	319.3	249.1	219.0	166.4	123.1	82.7	57.1	34.2	19.5	11.5	7.7	4.0	0.7

Maximum duration of high stages.

Months.	20.		25.		30.		35.		40.		45.		50.		55.		60.		High water of 1832.
	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Days.	Year.	Feet.
January	31	1870	25	1870	16	1870	15	1870	13	1870	11	1870	9	1870	5	1870			
February	26	1867	25	1867	20	1867	18	1867	14	1867	13	1867	12	1867	7	1867			63.6
March	31	1859 1867 1870	31	1867	30	1867	22	1867	21	1867	20	1867	16	1867	10	1867	5	1867	
April	30	1869	23	1870	19	1870	16	1870	14	1870	8	1870	2	1870					
May	25	1858	20	1858	17	1858	14	1868	6	1859	5	1859	4	1859					
June	23	1858	22	1858	21	1858	14	1858	7	1858									
July	9	1869																	
August	0																		
September	12	1868	10	1866	9	1866	4	1866	2	1866									
October	7	1866	4	1866	3	1866	2	1868											
November	11	1866																	
December	26	1866	16	1858	13	1858	8	1858	6	1858									

The marked discrepancy between the oscillations at the head and at the foot of the falls is due to the tendency of all rivers, when in flood, to obliterate all irregularities in their beds, and to establish a regular surface slope. During low stages the rise below the falls is three feet for one foot above. This ratio gradually decreases as the river rises, until a depth of 18 feet is attained at the head of the falls, after which the rise is the same above that it is below.

THE PADUCAH BRIDGE.

The authority to construct a bridge at Paducah was granted by the joint resolution of Congress approved April 7, 1869, (Appendix *A*,) which is suplementary to the act of July 14, 1862. The authority is exactly the same as that for constructing the Newport and Cincinnati bridge, and if the company so elect it will permit the construction of a similar bridge to that which Congress has just ordered to be raised. In our report of February 7, 1871, which has been printed as Executive Document No. 128 of the third session of the Forty-first Congress, we recommended that the joint resolution of April 7, 1869, be repealed, and that a general act be passed to regulate the construction of all future bridges over the Ohio, a copy of which is embodied in the report. [See Appendix E.] If built under this act it is believed that the bridge at Paducah will not be injurious to navigation. As no steps have yet been taken toward building this bridge, the law can now be readily changed.

There are no regular observations kept at Paducah of the rise and fall of the river, but the maximum oscillation is reported as 52¼ feet. As the duration of high stages is much longer in this portion of the river than it is above, there is a much greater necessity for a high bridge. The river slope in the lower Ohio is much more gentle than it is above the falls. From Pittsburgh to Beaver Shoals the fall averages 14 inches per mile, while from Portland to Cairo it is only 2⅓ inches per mile. This reduced fall makes a more gentle current, and as the river is quite straight above and below the bridge site, there ought to be no difficulty in passing through a 400-foot channel space. It should be remarked, however, that, as the proposed bridge is below the mouths of the Cumberland and the Tennessee, there will probably be a greater number of boats to pass this bridge. A low draw-bridge at this locality would be an even greater obstruction than at Cincinnati, and therefore the law authorizing one should be repealed.

The average duration of different stages of water, as reported by Mr. Harrington, the city engineer of Paducah, is as follows:

Between low water and 10 feet	6 months.
Between 10 and 20 feet	2½ months.
Between 20 and 30 feet	1½ months.
Between 30 and 40 feet	5 weeks.
Between 40 and above	3 weeks.
	12 months.

The duration of high stages is quite variable, however. The river averages 40 feet and over twice in every three years, though there have been periods of four successive years in which it did not rise so high, and then again in the four following years it was over 40 feet each year; and in one year it exceeded this height four times. The highest water ever known was in 1867, which exceeded all previous floods by 3 feet.

No definite location having been given to this bridge, we did not deem it necessary to take our surveying party to make current observations. A map accompanies this report showing the locality and the soundings as made by the bridge engineers in their preliminary surveys.

CONCLUSION.

The following tabular statement of the principal features of the bridges over the Ohio, together with the cost of each bridge as far as ascertained, is appended. Nothing but the actual cost between abutments has been taken, all land damages and connections with main track having been excluded:

	Length of approach from right bank.	Length of approach from left bank.	Total length including approaches.	Maximum grade per mile, (equated.)	Maximum curvature.	Above low water.	Above highest water.	Maximum local rise.	Width at low water of channel openings on axis of bridge.	Cost.
	Ft.	*Ft.*	*Ft.*	*Ft.*	° ′	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
Steubenville Railroad	.....	.....	1,895.4	.....	......	90	45	45	303½	(?)$1,000,000
Wheeling, (highway)	.....	.....	980	253	......	91½	48	43½	980	161,594
Bridgeport, (highway)	.....	.....	638	.....	......	53	9½	43½	212	68,500
Bellaire Railroad	1,490	864	4,001¼	60.3	5	90	40	50	322 220	Unfinished.
Parkersburgh Railroad	726	1,994	4,262	59.3	4 20	90	40	50	326¼ 326¼	$1,223,550
Newport and Cincinnati Railroad, as commenced.	950	230	2,961.5	57.2	10	71½	9	62½	400	*820,394
Newport and Cincinnati Railroad, as altered.	2,400	1,680	5,861.5	66.0	10	100	37½	62½	400	*1,109,089
Covington and Cincinnati, (highway)	.....	.....	1,619	283	......	103	40½	62½	1,005	1,480,000
Louisville Railroad	.....	....	5,218¾	79.1	......	96½	45½	51	380 352½	1,613,120
Paducah Railroad	.....	.....	.....	.....	.....	.....	.....	52½	....	Not begun.

* Estimated.

NOTE.—The lengths of earthen embankments are not included in the above.

The following maps and drawings accompany this report:

Railroad bridge at Steubenville.
Highway bridges at Wheeling and Bridgeport.
Railroad bridge at Bellaire.
Railroad bridge at Parkersburg.
Railroad and highway bridge at Newport. } On one sheet.
Highway bridge at Covington. }
Railroad bridge at Louisville.
Site of proposed railway bridge at Paducah.

Each sheet shows the plan of the bridge and a map of the river for at least half a mile above and the same distance below, on the scale of one inch to 200 feet, with all current observations accurately platted thereon. The profile of each bridge, and two elevations of a channel pier are given on a scale of one inch to 20 feet. Each sheet also contains a small map on a scale of two inches to the mile, showing the bends in the river for about five miles above and the same distance below. The Paducah sheet is like the others, excepting that no bridge is represented.

Appendix *A* contains the United States laws appointing the board of engineers and those authorizing the construction of the various bridges. Appendix *B* contains a statement of the losses sustained by collision with the piers of these bridges. Appendix *C* contains a statement of the sums paid by various parties to secure an additional channel span in the bridge at Parkersburgh. Appendix *D* contains our special report on the Newport and Cincinnati bridge, with the errors corrected which were made in the printing of it as H. Ex. Doc. 32 of third session Forty-first Congress. Appendix *E* contains our report (H. Ex. Doc. 128, third session Forty-first Congress.) February 7, 1871, submitting a project for a general law in relation to bridging the Ohio River, and our reasons for its provisions.

Respectfully submitted.

G. K. WARREN,
Major Engineers, and Bvt. Maj. Gen'l, U. S. A.
G. WEITZEL,
Major Engineers, and Bvt. Maj. Gen'l, U. S. A.
WM. E. MERRILL,
Major Engineers, and Brevet Colonel.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Appendix A.

PUBLIC.—No. 152.

AN ACT making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes, for the fiscal year ending June 30, 1871.

SEC. 5. *And be it further enacted,* That the Secretary of War is hereby authorized and required to detail three engineers, whose duty it shall be to examine all bridges now erected or in process of erection across the Ohio River, and to report whether, in their opinion, such bridges, or any of them, as now constructed, or proposed to be constructed, do or will interfere with the free and safe navigation of said river; and if they do or will so interfere, to report also what extent of span and elevation above water will be required to prevent obstruction to navigation, and their estimate of the cost required to change such bridges now built, or being built, to such width of span and elevation above the water as will prevent obstruction to navigation, such report to be made and communicated to the next session of Congress.

Approved July 11, 1870.

AN ACT to establish certain post-roads.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the bridge partly constructed across the Ohio River at Steubenville, in the State of Ohio, abutting on the Virginia shore of said river, is hereby declared to be a lawful structure: *Provided,* That when completed, if constructed without a draw, it shall leave an unobstructed headway in the channel of the river, of not less than ninety feet above low-water mark, and such channel or water-way shall have an unobstructed width of not less than three hundred feet between the piers next to said channel or water-way, and one of the spans next adjoining thereto shall not be less than two hundred and twenty feet in length; or said bridge, if constructed with a draw, the same to be constructed under the limitations and conditions provided in the fourth section of this act.

SEC. 2. *And be it further enacted,* That the said bridge and Holliday's Cove Railroad are hereby declared a public highway, and established a post-road for the purpose of transmission of mails of the United States, and that the Steubenville and Indiana Railroad Company, chartered by the legislature of the State of Ohio, and the Holliday's Cove Railroad Company, chartered by the State of Virginia, or either of them, are authorized to complete, maintain, and operate said road and bridge when completed, as set forth in the preceding section, anything in any law or laws of the above-named States to the contrary notwithstanding.

SEC. 3. *And be it further enacted,* That it shall be lawful for any other railroad company or companies whose line or lines of road may now or shall hereafter be built to the Ohio River, above the mouth of the Big Sandy River, in accordance with the terms of the charter or charters of such company or companies, to build a bridge across said river for the more perfect connection of any such roads and for the passage of trains thereof, under the limitations and conditions hereafter provided.

SEC. 4. *And be it further enacted,* That any bridge erected under the privileges of this act may, at the option of the company or companies building the same, be built either as a draw-bridge, with a pivot or other form of draw, or with unbroken and continuous spans: *Provided,* That if the said bridge shall be made with unbroken and continuous spans, it shall not be of less elevation than ninety feet above low-water mark over the channel of the said river, nor in any case less than forty feet above extreme high water, as understood at the point of location, measuring for such elevation to the bottom of the bridge; nor shall the span of such bridge covering the main channel of the river be less than three hundred feet in length, with also one of the next adjoining spans of not less than two hundred and twenty feet in length, and the piers of said bridge shall be parallel with the current of the river as near as practicable: *And provided also,* That if any bridge built under this act shall be constructed as a draw-bridge, the same shall be constructed with a span over the main channel of the river, as understood at the time of the erection of the bridge, of not less than three hundred feet in length, and said span shall not be less than seventy-feet above low-water mark, measuring to the bottom chord of the bridge, and one of the next adjoining spans shall not be less than two hundred and twenty feet in length, and also that there shall be a pivot draw constructed in every such bridge at an accessible and navigable point, with spans of not less than one hundred feet in length on each side of the central or pivot pier of the draw: *And provided also,* That said draw shall always be opened promptly, upon reasonable signal, for the passage of boats whose construction may not at the time admit of their passing under the permanent spans of said bridge, except that said draw shall not be required to be opened when engines or trains are passing over said bridge, or when passenger trains are due, but in no case shall unnecessary delay occur in the opening of said draw after the passage of such engines or trains.

SEC. 5. *And be it further enacted,* That any bridge or bridges erected under the provisions of this act shall be lawful structures, and shall be recognized and known as post-routes, upon which, also, no higher charge shall be made for the transmission over the same of the mails, the troops, and munitions of war of the United States than the rate per mile which the company or companies erecting such bridge may from time to time receive on the balance of their line or lines for such services, and the officers and crews of all vessels, boats, or rafts navigating the said Ohio River are required to regulate the use of the said vessels and of any pipes or chimneys belonging thereto, so as not to interfere with the elevation, construction, or use of any of the bridges erected or legalized under the provisions of this act.

Approved July 14, 1862.

AN ACT making appropriations for the service of the Post-Office Department during the fiscal year ending the thirtieth of June, one thousand eight hundred and fifty-three, and for other purposes.

SEC. 6. *And be it further enacted,* That the bridges across the Ohio River at Wheeling, in the State of Virginia, and at Bridgeport, in the State of Ohio, abutting on Zane's Island, in said river, are hereby declared to be lawful structures in their present position and elevation, and shall be so held and taken to be, anything in any law or laws of the United States to the contrary notwithstanding.

SEC. 7. *And be it further enacted,* That the said bridges are declared to be and are established post-roads for the passage of the mails of the United States, and that the Wheeling and Belmont Bridge Company are authorized to have and maintain their said bridges at their present site and elevation; and the officers and crews of all vessels and boats navigating said river, are required to regulate the use of their said vessels and boats, and of any pipes or chimneys belonging thereto, so as not to interfere with the elevation and construction of said bridges.

Approved August 31, 1852.

A RESOLUTION giving the assent of the United States to the construction of the Newport and Cincinnati bridge.

Resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of Congress be, and the same is hereby, given to the erection of a bridge over the Ohio River from the city of Cincinnati, Ohio, to the city of Newport, Kentucky, by the Newport and Cincinnati Bridge Company, a corporation chartered and organized under the laws of each of the States of Kentucky and Ohio: *Provided,* That said bridge is built with an unbroken or continuous span of not less than four hundred feet in the clear, from pier to pier, over the main channel of the river, and is built in all other respects in accordance with the conditions and limitations of an act entitled "An act to establish certain post-roads," approved July fourteenth, eighteen hundred and sixty-two. That said bridge, when completed in the manner specified in this resolution, shall be deemed and taken to be a legal structure, and shall be a post-road for the transmission of the mails of the United

States; but Congress reserves the right to withdraw the assent hereby given in case the free navigation of said river shall at any time be substantially and materially obstructed by any bridge to be erected under the authority of this resolution, or to direct the necessary modifications and alterations of said bridge.

Approved March 3, 1869.

AN ACT to establish a bridge across the Ohio River, at Cincinnati, Ohio, a post-road.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the bridge across the Ohio River at Cincinnati, in the State of Ohio, and at Covington, in the State of Kentucky, is hereby declared to be, when completed, in accordance with the laws of the States of Ohio and Kentucky, a lawful structure and post-road for the conveyance of the mails of the United States.

Approved February 17, 1865.

AN ACT supplementary to an act approved July fourteen, eighteen hundred and sixty-two, entitled "An act to establish certain post-roads."

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the act of Congress approved July fourteen, eighteen hundred and sixty-two, entitled "An act to establish certain post-roads," shall be, and the same is hereby, so amended as to authorize the Louisville and Nashville Railroad Company, and the Jeffersonville Railroad Company, (stockholders in the Louisville Bridge Company,) to construct a railroad bridge over the Ohio river at the head of the falls of the Ohio, subject to all the provisions of said act: *Provided,* That the said bridge may be constructed at a height not less than fifty-six feet above low-water mark, and with three draws, sufficient to pass the largest boats navigating the Ohio River: one over the Indiana chute, one over the middle chute, and one over the canal: *Provided,* That the spans of said bridge shall not be less than two hundred and forty feet, except over the Indiana and middle chute and the canal; said bridge shall be constructed with draws of one hundred and fifty feet wide on each side of the pivot pier over the Indiana and middle chutes, and ninety feet wide over the canal: *And provided further,* That said bridge and draws shall be so constructed as not to interrupt the navigation of the Ohio River.

SEC. 2. *And be it further enacted,* That the bridge erected under the provisions of this act shall be a lawful structure, and shall be recognized and known as a post-route.

Approved February 17, 1865.

JOINT RESOLUTION authorizing the building of a railroad bridge over the Ohio River at Paducah, Kentucky.

Be it resolved by the Senate and House of Representatives of the United States of America in Congress assembled, That the consent of Congress be, and the same is hereby, given to the erection of a railroad bridge over the Ohio River from the city of Paducah, Kentucky, to the State of Illinois, by the Paducah and Gulf Railroad Company and such others as may associate with them for that purpose under the laws of the States of Kentucky and Illinois: *Provided,* That said bridge is built with an unbroken or continuous span of not less than four hundred feet in the clear, from pier to pier, over the main channel of the river, and is built in all other respects in accordance with the conditions and limitations of an act entitled "An act to establish certain post-roads, approved July fourteen, eighteen hundred and sixty-two;" that the said bridge, when completed in the manner specified in this resolution, shall be deemed and taken to be a legal structure, and shall be a post-road for the transmission of the mails of the United States; but Congress reserves the right to withdraw the assent hereby given in case the free navigation of said river shall at any time be substantially and materially obstructed by any bridge to be erected under the authority of this resolution, or to direct the necessary modifications and alterations of said bridge.

Approved April 7, 1869.

Appendix B.

Official statement of losses by collision with the piers of bridges over the river.

STEUBENVILLE BRIDGE.

Date.	Owners.	Tow-boats.	Losses.	Amount.
May, 1863	John F. Dravo		Two floating boats and coal.	$5,000
July 25, 1865	Horner, Wood & Co.	Warrior	One barge and coal	3,350
May 9, 1867	William H. Brown	Mary Davage	Two barges and coal	5,600
March 12, 1868	Hays Coal Company	Diamond	do	4,500
	Stone & Co	Coal Valley	Three barges and coal	8,500
	J. N. & W. O'Neil & Co.	Fred Wilson	One barge and coal	2,300
April 22, 1869	Horner, Wood & Co	Ella	Two barges and coal	4,000
	do	do	One flat-boat and coal	2,500
	do	do	One fuel-boat	900
December 2, 1869	William H. Brown	Sampson	Seven barges and coal	17,638
	do	do	Five fuel boats	4,500
December 5, 1869	Horner, Wood & Co	Simpson Horner	One flat-boat and coal	2,800
Total				61,588

BELLAIRE BRIDGE.

Date.	Owners.	Tow-boats.	Losses.	Amount.
December 5, 1869	B. M. Laughlin	Boaz	One brick-boat and bricks	$2,500
	William H. Brown	Resolute	One flat-boat and coal	2,000
	Dippold & Co	Reindeer	One barge and coal	2,000
January 14, 1870	J. D. Johnson & Co	Star	Steamer total loss	28,000
	do	do	Six barges and coal	12,000
	do	do	One coal-boat and coal, (two lives lost.)	2,000
March 1, 1871	J. V. McDonald & Co	Lioness	Two barges and coal	6,000
March 2, 1871	N. J. Bigley	Picket	One coal-boat and coal	3,000
March 3, 1871	Marsh McDonald	Fearless	do	3,000
Total				60,500

PARKERSBURGH BRIDGE.

Date.	Owners.	Tow-boats.	Losses.	Amount.
March 12, 1868	Dippold & Co	Tigress	One barge and coal	$2,000
September 4, 1869	J. Gilmore	Gilmore	do	2,000
December 5, 1869	Hays Coal Company	Diamond	Two barges and coal	4,000
December, 1869	William Robbins	Gilmore	One barge and coal	2,000
December 25, 1869	J. Gilmore	do	do	2,000
January 30, 1870	William H. Brown	Greyhound	do	2,000
		PASSENGER BOATS.		
January, 1870	Boothe, Battelle & Co	Rebecca	Steamer total loss, (lives lost.)	30,000
February 6, 1870	do	Major Anderson	Steamer damaged	1,400
November 24, 1869	W. Guss & Co	Ellena May	Steamer damaged, (pilot injured.)	500
Total				45,900

NEWPORT AND CINCINNATI BRIDGE.

Date.	Owners.	Tow-boats.	Losses.	Amount.
December, 1870	Mulvehill & Company	Tom Reese, No. 2	One barge and coal	$2,000
December, 1870	Peytona Coal Company	Pierpont	do	2,000
Total				4,000

LOUISVILLE BRIDGE.

Date.	Owners.	Tow-boats.	Losses.	Amount.
December 13, 1869	J. S. McDonald	A. J. Baker	One coal-boat and coal	$3,000
December 25, 1869	William H. Brown	Mary Alice	Four coal-boats and coal	15,892
December 25, 1869	do	do	One barge and coal	1,812
March 15, 1869	J. S. McDonald	Hornet	do	2,000
May, 1870	Stuart & Graves	Bengal Tiger	do	2,000
February 25, 1871	A. J. Hutchinson	Newcomb	do	2,000
Total				26,704

Grand total of losses at bridges, $198,692.

The losses by collision with the piers of bridges spanning the Ohio River, heavy as it is, constitutes but a small item of the aggregate loss resulting from such obstructions. The great loss sustained is by detention arising from the necessity of landing our tow-boats and waiting for daylight, not daring to run the narrow channel-ways at night, thus involving loss of time and extra expense of crews and fuel, in addition to the extra hazards of landing our immense tows. Even passenger boats, at certain stages of water, have to land and wait for daylight. The aggravating character of these obstructions will be apparent if we suppose the trains of any important railroad under the necessity of stopping every fifty or one hundred miles to wait for daylight, to pass certain artificial obstructions crossing their road. Would it be endured? This is precisely the hardship imposed upon the river navigation by bridge obstructions.

JOHN F. DRAVO,
President Pittsburgh Coal Exchange.

Appendix C.

Subscriptions to Parkersburgh Bridge Fund.

		Am't paid.
1.	W. H. Brown	$4,100 00
2.	Horner, Wood & Co	2,460 00
3.	J. C. Risher & Co	1,640 00
4.	Joseph Walton & Co	1,640 00
5.	Thomas Fawcett	820 00
6.	Hays Coal Company	820 00
7.	N. J. Bigley	1,640 00
8.	J. V. McDonald	820 00
9.	D. & J. S. McDonald	820 00
10.	Lysle & Son	820 00
11.	Bayley, Whigham & Co	820 00
12.	Briggs & Mulvehill	820 00
13.	O'Neil & Co	820 00
14.	John Dippold	574 00
15.	Hornet Coal Co	820 00
16.	John Gilmore	820 00
17.	J. D. Johnson, Star Coal Co	410 00
18.	Duncan Cornell & Co	820 00
19.	William Stone	820 00
20.	James Blackmore	820 00
21.	Miller & Williams	820 00
22.	James Watson	820 00
23.	Dunshee, Whitmore & Co	656 00
24.	R. C. Gray	820 00
25.	Miller & Lyon	656 00
26.	Joseph Nixon	164 00
27.	Samuel Clarke & Sons	820 00
28.	W. Mars	410 00
29.	T. W. Fowler	246 00
30.	J. S. Neel & Co	820 00
31.	Iron City Coal Co	820 00
32.	Staib & Co	164 00
33.	Warner Coal Co	400 00

	Am't paid.
34. W. S. Packer	$300 00
35. B. F. Wilson	136 67
36. Samuel Roberts	136 67
37. William Cunningham	136 66
38. Thomas Jones	136 67
	31, 586 67

Paid bridge company	$30, 000 00
Committee expenses for collections, traveling, visiting Washington City and Parkersburgh, attorney's fees, &c	1, 586 67
	31, 586 67

JOHN F. DRAVO,
President Pittsburgh Coal Exchange.

Appendix D.

DECEMBER 12, 1870.

To Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army.

GENERAL: The board appointed by your order, in accordance with section 5 of the act making appropriations for the improvement of rivers and harbors, approved July 11, 1870, have examined the Newport and Cincinnati bridge, now in process of construction over the Ohio River, and present the following special report upon this work.

Section 5, referred to above, is as follows:

"*And be it further enacted*, That the Secretary of War is hereby authorized and required to detail three engineers, whose duty it shall be to examine all bridges now erected or in process of erection, across the Ohio River, and to report whether, in their opinion, such bridges, or any of them, as now constructed, or proposed to be constructed, do or will interfere with the free and safe navigation of said river; and if they do or will so interfere, to report also what extent of span and elevation above water will be required to prevent obstruction to navigation, and their estimate of the cost required to change such bridges now built, or being built, to such width of span and elevation above the water as will prevent obstruction to navigation, such report to be made and communicated to the next session of Congress."

The duties imposed by the above law are so thorough and comprehensive as to require a lengthened report. To facilitate its consultation by those who wish to arrive at a knowledge of only the general features of the case, and of our conclusions and recommendations, we have made the first part of our report somewhat of a summary of the whole, and have placed the details of each division of the subject in separate chapters, for the use of those who wish to thoroughly examine the subject and judge for themselves.

The Newport and Cincinnati Bridge Company possess, under the law approved July 14, 1862, and the joint resolution approved March 3, 1869, the option of building a bridge not less than 40 feet above the highest water without a draw-span, or a bridge not less than 70 feet above lowest water with a draw-span, with the reservation by Congress of the right to withdraw the assent given "in case the free navigation of the river shall at any time be substantially and materially obstructed by any bridge to be erected under the authority of this resolution, or to direct the necessary modifications and alterations of said bridge."

We are unanimously of the opinion that this bridge, as being constructed, is a serious obstacle to the free navigation of the Ohio River; and that it imperatively calls upon Congress to exercise its specially reserved right of modification.

In order to assist to a full and clear comprehension of the subject in all its phases, we have thought it proper to present a brief abstract of the course of legislation and debate upon this subject of bridging the Ohio, since the introduction of the bill which, in a modified form, became the law approved July 14, 1862. This history is presented in the next chapter, and is made up from the debates in the Congressional Globe and the statements of members of Congress who voted for the joint resolution.

From this it appears that the law approved July 14, 1862, providing that the largest span should be 300 feet, was only agreed to at that time by the river interests on account of the alleged impracticability of making longer spans at reasonable expense. One of the provisions of this law required that if the bridge was built without a draw, it should not be less than 90 feet above lowest water, and not less than 40 feet above highest water. These prescribed elevations made this part of the law applicable to places of varying ranges between high and low water; but its operation was expressly limited to the Ohio River, above the mouth of the Big Sandy. As some members of Congress were apprehensive that the bridge, if built at so great an elevation, would be insecure, a provision was made that the bridge might be built at 70 feet above lowest water, with a pivot-draw giving two clear openings of 100 feet each. Unfortunately this alternative provision made no stipulation about the height above highest water of bridges using draws, and this has since become a very serious omission, in consequence of its operations having been extended so as to include Cincinnati. Seventy feet above lowest water is at least 25 above highest water at Steubenville, while at Cincinnati 70 feet above lowest water is but 7½ feet above highest water. The reasons for requiring the draw openings to be only 100 feet do not appear in the debates, but they were pronounced too narrow at the time by several members.

It has been stated that the joint resolution approved March 3, 1869, was a compromise between the navigation and bridge interests; and so it undoubtedly was in regard to length of span. The navigation interests had been striving to secure 500-foot spans instead of 300, and the compromise was on 400 feet for the main span. Representatives J. K. Moorhead, Benjamin Eggleston, and S. F. Cary, who voted for the joint resolution, state that it was with the express understanding that the bridge was not to be of less height than the existing suspension bridge, or not less than 40 feet above highest water. It is most unfortunate that this understanding was not made a part of the resolution itself. But the neglect of the bridge companies at Steubenville, Bellaire, and Parkersburgh, to build low bridges, under the act of July 14, 1862, caused this provision of this act for a low bridge to be overlooked. The provision for a high bridge under this law would have been satisfactory. These facts show that the compromise, as understood by those who made it, has not been complied with in building the bridge at Cincinnati on the draw-bridge plan, and that it lacks the essential quality of a compromise in not being understood in the same sense by those who are said to have made it; and hence it cannot be made a reason for Congress refraining from exercising the reserved right to compel the modification of the bridge itself. The Government of the United States is the custodian of the public rights on these great navigable streams; and though parties interested in special branches of trade may consent to certain designs of bridges, the Government alone, comprehending all interests, should be the final judge in such matters.

It is proper to state here in regard to long spans of 400 feet and upward, that they are not impracticable at reasonable expense, and that when properly proportioned, they are much more stable and safe than smaller spans, because their own weight is so great in proportion to the moving load that the latter changes the permanent strain but little. High piers proportionally widened and lengthened are just as firm as low ones, and the greatest pressure the stone has to sustain is not one-tenth of its crushing load. Those who wish to see these points illustrated can do so by visiting Louisville and examining the bridge built at that place across the Ohio—an admirable structure that overcomes every objection that can be made against a high bridge.

A detailed description of the Newport and Cincinnati bridge as it is "in process of erection" is given further on. From this it will be seen the bridge is to be 71½ feet in the clear above low water, and 9 feet above highest water at the main channel span. This span is 400 feet between the piers. The piers, however, are not parallel with the current, but make an angle of 12° with it. The practical effect of this want of parallelism is to reduce the width of the span to 390 feet, which is less than the law requires.

The foundations of the piers are not laid deep enough in the bed of the river, and will require protection; and unless this is done with care and at considerable expense, there will be a still further reduction of the channel-way. Our examination was made when the river was 6 feet above the lowest stage. It is probable that the course of the current is not materially different at other stages, and therefore we have to report that the piers are not parallel with the current, as the law requires.

This angle, which the piers make with the current, is occasioned by the line of the bridge being taken so as to accommodate the railroad approaches from the Little Miami depot. On this account, too, there is a curve with a radius of 609 feet on the bridge, over two spans of 96 feet each, on the Cincinnati side. This curve compelled the use of these two short spans, where otherwise a single span would have been better. The cost of the bridge was thus increased, and the flow of the river at high water was obstructed.

Under the law one of the spans, next the main span, must give a clear opening of 220 feet, and as the curve spoken of above would not allow of its being placed on the Cincinnati side, it was placed on the Newport side of the main span. Although this main span is over the deepest water, it is said that the main flow at high water is somewhat on the Newport side of it, and it would have been better to have placed the 220-foot span on the Cincinnati side, and the 400-foot span 200 feet nearer the Newport side. The position of this main span is not in violation of the law, but its location might have been made so much better for navigation, that this fact alone demonstrates the importance of having an officer of the Government to supervise the location of bridges.

At the draw-span both of the rest-piers are at right-angles with the bridge, and make an angle of 12° with the current. The pivot-pier and its protection, however, are built parallel with the current, and not parallel with the adjoining piers. This presents a very dangerous appearance to the navigator, although the mathematical decrease in the width of the opening, measured at right-angles with the current, is less than a foot. The width is about 100 feet, and is not enough for any place on the Ohio River. On the Mississippi River, all bridges built under the existing laws of the United States are required to have two draw-openings of at least 160 feet each.

The piers of the Newport and Cincinnati bridge occupy about 12½ per cent. of the ordinary high-water section of the river, and probably increase the high-water velocity of the current at that rate.

For further details of the piers and approaches, and their cost, see the chapter on this subject. The gross cost of these, according to our estimate, is $417,151.

The description of the superstructure of the main bridge and its cost are given in a special chapter. The entire length of the bridge, between the shore abutments, is 1,781½ feet. The bridge, as now arranged for the railroad, is a "through-bridge," giving 13 feet in the clear between the trusses. Outside of the trusses, and supported by floor beams suspended from the ends of the posts, are narrow wagon-ways, 6 feet wide, with sidewalks 2½ feet wide. The situation of these wagon-ways is not good, on account of the liability of horses becoming frightened at the locomotives. The width of the bridge over all is 38½ feet. The draw-span is to be turned on its pivot by machinery, to be worked by men or by steam. There is one truss at present erected, of 202½-foot span, which is about 27 feet in height. We have not been furnished with the height proposed for the 400-foot span. It probably cannot be less than 40 feet. The superstructure is uncommonly high and wide for the width of base on which it stands, which does not conduce to its stability.

The gross cost of the superstructure of the bridge over the river, according to our estimate, is $375,500. This makes the total cost of the bridge, as now being constructed, $792,651.

In the foregoing we have not included the cost of land purchased. But little of this is so occupied by the bridge as not to be available for other purposes, and the increased value of the property makes this probably a source of profit rather than expense. It may be proper to increase the estimate by the interest on about one-third of the total cost for the space of one year and a half at 7 per cent., which would be about $27,743. This covers the expense of carrying the money expended on the work before it becomes productive. The bridge, when finished on present design, would then have absorbed a capital of $820,394, all told.

The effect of the bridge upon navigation is discussed in detail in a separate chapter, and it is evident from the considerations there presented that the bridge, as in process of erection, requires modification and alteration. We think the main span should be raised 28½ feet higher than it is now designed, thus giving a clear headway of 100 feet above lowest water, and 37½ feet above highest water. Even this headway is not quite equal to that of the suspension bridge, which is 103 feet above lowest water. We would keep the main 400-foot span as a "through-bridge," and raise all the other spans so as to make them "deck-bridges" for the railroad track. This will lengthen the railroad approaches so as to make them 2,350 feet long on the Newport side, and 3,050 feet long on the Cincinnati side, measuring from the abutments next to the river.

We have preserved the alignment as it was before, so that there are no rights of property to acquire, and the streets are nowhere much more obstructed than at present, while Eggleston avenue, in Cincinnati, now closed by the existing railroad approaches, is opened. We have adopted as a maximum grade for the approaches 66 feet per mile on tangents, for the reason that the railroad connecting the bridge with the Short-line Railroad to Louisville has a grade of 60 feet per mile on a 6° curve, which is considered equivalent to 69 feet per mile on a tangent. Any train that can pass over this road can cross the bridge without assistance.

As Cincinnati is a principal station where trains are made up and switch-engines are constantly at hand, plenty of auxiliary power will always be available in case the bridge should hereafter be made to connect roads with easier ruling grades. Had we relied on this fact, we might have recommended grades on the bridge approaches of 90 feet, or even of 116 feet, per mile, and thereby have considerably diminished the cost of construction, but to avoid getting into a discussion on this point, we have taken the same ruling grade that already controls the roads connected, against which there can be no objection. The grades on the Louisville bridge up to the channel-spans are 78 feet per mile. On the curves of the Cincinnati approach to this bridge we have reduced the grade a foot and a half per mile for each degree of curvature. On the Newport side the approach is on a grade of only 30 feet per mile, except for 537 feet, in which it has a grade of 66 feet per mile, the lesser grade being made thus easy on account of the necessity of crossing Jefferson street at a sufficient elevation to leave there a headway of 12 feet for the street travel. A great reduction of curvature and grade could be made on the Cincinnati side by a slight change in location, but we have not done this, because we wished to avoid questions of purchase of property. The company, when raising the bridge, can make such changes in this respect as may be most advantageous to themselves.

According to the design upon which the bridge is building, the railroad track gets down to the grade of the Little Miami Railroad near the depot grounds. In the proposed modification the track at that point will be about 25 feet above the present one at the depot, but by building a new passenger depot with one front of it on Pearl street, the floor would be placed on a level with the track. The building of this depot will be supplying a want of the road, and is not properly chargeable to the bridge.

It only remains to be added that we have calculated the weight which the piers will have to stand, when raised, and find that it will not be one-tenth of the load required to crush the poorest stones employed in constructing them.

Our estimate of the amount of money required to make the proposed change is $288,695; the details are given further on. If the change should be delayed till the 400-foot span is erected, the cost would be somewhat increased. The bridge, when remodeled, will then have cost, all told, $1,109,089.

Had the high plan been adopted at first, the cost of the pivot-pier and all its appurtenances, the cost of part of the brick-work in the railroad approaches, the cost of the wooden trestle-work between Front street and Eggleton avenue, which we replace with iron trestles, and piers, and bridge, and, finally, the extra cost of raising the piers and trusses from one plan to the other, would have been saved. Taken all together the amount of money in this last estimate that might have been saved is about $132,000, so that the high bridge, if built at first, would have cost $977,089.

It cannot be claimed, however, that $1,109,089 is too much money to put in a bridge across the Ohio River. The suspension-bridge cost more than this, and so did the bridge at Louisville.

The work is progressing rapidly, and it would be safe to conclude that, before any action can be had by Congress, all the substructure will be finished, and the superstructure of three or four of the minor spans erected. The 400-foot span, however, cannot be finished, nor can the draw-span and the others, if erected subsequently, be raised without increased expense beyond what we have estimated for. The proper protection to the foundation of the piers, for which we have allowed in our estimate of the cost, remains to be made.

It seems called for, even in this special report, that we should give our opinion as to the kind of general legislation that should be had in regard to bridges across the Ohio River. The demand for these bridges is increasing, and Congress, for its own protection, ought now to finally dispose of the subject in such a way that the river interests should no longer be threatend with destruction, and that bridge companies might no longer hope for special favors, but be compelled to work on a well-understood and digested plan. The capabilities of engineering and the resources of the railroad corporations are ample to meet any just requirements of navigation.

It is not uncommon to hear the navigation of the Ohio disparaged; to hear repeated the false assertion that the river is dry one-half of the year, and frozen up the other half; and to be told that the interest at most is a local one.

In another part of this report is given a condensation of the official record of the river at Cincinnati for the last twelve years, which shows the average condition for each month. From this it can be seen that for three hundred and twenty-six days in each year the river is at least 5 feet above low-water; for two hundred and fifty-three days, at least 10 feet above; and for one hundred and ninety-one days, at least 15 feet above. This represents the condition of the river from as high up as Portsmouth, at the mouth of the Sciota River, down to Louisville. On this part of the river vessels are almost constantly running that are 300 feet long, and each one carries on an average 150 tons per day, or 4,500 tons per month. This is enough to show the capacity of the river, in the space considered, without taking into account the business of the coal and other barges moved by tugs. The statistics of commerce show the river business to be greatly increasing. The same advances which are seen in other great lines of transportation are seen here. Vessels are being built of increasing size and value, and the Government is removing great obstructions which have hitherto retarded development. One can see the growth of the nation in contemplating our great river commerce as plainly exhibited as it is on our great inland lakes, in our coasting trade, or even in the railroad lines themselves, and no American can see it without being proud of it.

The interest is anything but a local one, and while the bridge itself may be regarded as local, the principles involved in allowing it to be placed across a great navigable highway apply to every navigable stream in the country, and are worthy of the consideration of every man having a voice in the matter.

We think, if Congress should compel the alteration of the Newport and Cincinnati bridge, as we recommend, and should repeal or modify the joint resolution approved

April 7, 1869, authorizing a bridge at Paducah, that this action would be acceptable to all the river interests. Then let a general law be passed that hereafter all bridges to be built across the Ohio River shall have at least one span giving a clear opening 400 feet wide, measured at right angles to the stream, as near as practicable, and that the headway under this span shall not be less than 100 feet from lowest water nor less than 40 feet from highest water. These two requirements about the height make the provision apply to all places. Where the river oscillates less than 60 feet between low and high water, 40 feet above high water is not enough, as it does not furnish sufficient headway for long-continued intermediate stages of the water.

In addition to the above requirements, all bridges below Cincinnati should have a draw-span, giving a clear passage-way, 160 feet wide, placed so as to be available in the highest stages of the river for the use of the large packet-steamers that cannot at that time pass under the bridge. This may be an important provision in case of a war requiring the transportation of large numbers of troops along the river.

There is already a draw in the Louisville bridge, half of which is over the canal, that will soon be made available for the river by altering a part of the canal-bank. We think it would have been advisable to have had draws in all the bridges above Cincinnati, but there are so many bridges already built there without them that it is too late to consider the subject.

It is further of the greatest importance that the law should specify some branch of the Government to supervise its execution. Special cases will arise at each locality that can hardly be foreseen and provided for in a general law. It is believed, however, that a general law can be passed that will sufficiently meet all cases without imposing any additional expense or delay upon bridge companies if its operations be put under the direction of some Government engineer.

The bridge companies have not generally shown a desire to have the advice of the Government officers in charge of the river improvements. These officers have in no case been consulted, though their advice, before commencing, would have cost nothing, and would greatly have strengthened the position of the bridge company.

Where bridge interests have needlessly obstructed navigation, they are without excuse, and in correcting their mistakes there need be felt no apprehension of trespassing upon vested rights, as these rights were made conditional upon not obstructing navigation.

The following documents and maps accompany this report:

The acts of Congress under which this bridge is being built.

Map showing the location of the bridge in reference to the cities of Newport and Cincinnati, with recorded current observations and soundings. Also, on the same sheet, a map of eight miles of the river, showing its curvature above and below Cincinnati.

Four photographs of the bridge, taken on the 26th and 27th of November, showing its condition at that time.

HISTORY OF THE LAWS UNDER WHICH THE NEWPORT AND CINCINNATI BRIDGE IS BEING BUILT.

This bridge has been designed under the law approved July 14, 1862, authorizing the building of bridges over the Ohio River, above the mouth of the Big Sandy River, modified by the joint resolution approved March 3, 1869, and under the alternative that permits of a bridge being built here with a span of 400 feet over the main navigable channel, with one of the adjoining spans, giving a clear opening of 220 feet at a height of 70 feet above low water, provided a draw is made at an accessible and navigable point, giving two clear openings of 100 feet each; and provided that the piers are parallel with the stream as near as practicable. There is no reason given in the debates in Congress for adopting this height of 70 feet above low water, nor for the width of draw of 100 feet. The chief river interests that opposed the original bill for erecting the Steubenville bridge, which proposed only spans of 200 feet, were those of the coal boats and rafts; but Mr. Willey, United States Senator from Virginia, and Mr. Wilkinson, United States Senator from Minnesota, protested then that the draw was inadequate for steamboats. The raft and coal-boat interests were most earnest in demanding a wide channel-span, but finally consented, through Senator Cowan, to a span of 300 feet. In the bill, as finally passed, the bridge-builders were allowed the option of building without a draw, provided that they raised the bottom chord of the 300-foot span to 90 feet above low water, and to 40 feet above high water, which thus made the law for the high bridge accommodate places where the range from high to low water differed from that at Steubenville. But, singularly enough, there was no such provision with regard to the alternative of the draw-bridge plan. On the latter plan the bridge was required to be but 70 feet above low water, but no provision was made in regard to the height above high water. The river rises at Steubenville from low water to highest water, 45 feet; consequently the draw-bridge plan, if adopted there, would have been 25 feet above high water. The rise from low to highest water at Cincinnati is 62½ feet, so that the bridge, which is there 71½ feet above low water, is only 9 feet above the highest water, which is barely enough for its own safety. The fact that the original act was limited to the Ohio River above the Big Sandy, shows that its enactors never contemplated its being applied to points below. The debates in full will be found in parts three and four of the Congressional Globe, second session of the Thirty-seventh Congress, pages 2230, 2247, 2419, 2539, 2850, 3050, 3111, 3112, 3113, 3114, 3115, 3195, 3197, 3216.

The Steubenville Bridge Company accepted the alternative in the law which required the bridge, if without a draw, to be 90 feet above low water. This settled the long-contested point of ability to build railroad bridges with 300-foot spans. Incidentally it may be here said of this bridge, that it violates the requirements of the law in not having its piers parallel with the current as near as practicable; and, moreover, the defective foundations have compelled the use of riprap around the piers, so as to occupy about 40 feet of the space the law required to be left unobstructed. (See report of Senate Committee on Post-Offices and Post-Roads, No. 168, second session, Fortieth Congress, pages 5, 11, and 12.)

The bridging of the Ohio River was again introduced into Congress by House bill No. 384, second session, Fortieth Congress, (Congressional Globe, page 473.) A substitute to it was passed through the House February 27, 1868, after considerable debate. (See pages 1471, 1472, 1473.) This substitute authorized the building of a bridge at Paducah, under the provisions of the act approved July 25, 1866, for bridging the Mississippi River. On the same day the House passed House bill No. 755. (See Congressional Globe, page 1473.) The bill, as first introduced, extended the privileges of the act approved July 14, 1862, down as far as the mouth of the Licking River, so as to include the Newport and Cincinnati bridge; but, as finally passed, it was so amended that the bridge was required, if a high bridge, to be not less than 50 feet from the bottom chord to the level of high water, with a clear span of 250 feet; and, if a low bridge, it was to have a pivot-draw giving two clear openings of 160 feet each, so that its provisions were nearly the same as the bill for the bridge at Paducah, and for that at Quincy, Illinois, and at other points on the Mississippi River.

On the 22d of June, 1868, Mr. G. B. Raum, member from Illinois, introduced a joint resolution, No. 305, (see Globe, page 3364,) providing that hereafter all bridges building or to be built over the Ohio should have one span, giving an unobstructed width of 500 feet, and that the bottom chord should not be less than 50 feet above high water. This came up again in the order of business on July 6, (Globe, page 3760,) and was amended so as not to apply to the bridge at Louisville. In this shape it passed the House.

House bill No. 384 was referred to Senate Committee on Post-Offices and Post-Roads, March 4, 1868, (Globe, page 1658;) reported back with amendment, page 1863; motion made by Mr. Norton to recommit, page 2509; discussed, pages 2545, 2546, 2547, 2548; recommitted, page 2548; reconsidered and discussed, pages 2556, 2557, 2558, 2559. Many interesting facts relating to navigation, especially in regard to size of barges, coal-tows, &c., were produced in these last discussions. House bill No. 384, also No. 725, and several memorials on the subject of bridging the Ohio, were referred to the Committee on Post-Offices and Post-Roads in the Senate. This Senate Committee, on May 25, (Congressional Globe, page 2159,) made their report (Globe, page 4093) on the 16th of July, 1868. It is No. 168, second session, Fortieth Congress. It was accompanied by a general bill, No. 622, for bridging the Ohio River. This bill at first did not fix the width of greatest span required. It was recommitted July 17, (Globe, page 4145,) and reported back on the same day, (Globe, page 4146.)

As finally reported by the committee, it required one span, giving a headway of 40 feet above high water, and 500 feet clear width of passage-way.

The committee report, No. 168, is quite full upon the subject of bridging the Ohio, and presents all the main features of the case. It makes an unimportant error in stating, on page 2, that the object of House bill No. 725 was to extend the provisions of the act of July 14, 1862, down to the mouth of the Licking River. This was the effect of the bill as it was introduced, but, as passed in the House, it was so amended as to make the provisions of the bill for bridging the Mississippi, approved July 25, 1866, applicable to the Ohio, between the mouths of the Big Sandy and Licking Rivers.

The debates on the Senate bill No. 622, as finally reported by the Committee on Post-Offices and Post-Roads, are found in the Congressional Globe, second session, Fortieth Congress, pages 4199, 4200, 4201, 4202, 4203, 4204, 4267, 4268, 4269, 4283, 4284, 4285, 4286, 4287, 4289, 4290, 4291, 4292.

The result of the debate in the Senate was to pass a substitute for the bill as first reported by the committee, which directed that the President should appoint a board of scientific engineers, not more than seven nor less than five in number, who should report to the next session of Congress the proper width of spans in railroad-bridges across the Ohio River, that they might be adapted to the wants of navigation on that river; and that, until Congress should, by law, take action upon said report, no bridge should be constructed over said river, &c. But this provision was not to apply to the bridge in process of construction over the Ohio, at Louisville.

On July 25, Mr. Hendricks submitted to the Senate another resolution to appoint a board of three engineers to make a survey of the Ohio River, where bridges were projected, and to report what length of span was necessary to meet the requirements of navigation and of the public interest, (Globe, page 4462.) No action was taken on this resolution.

Senate bill No. 622 was received in the House July 22, (Globe, page 4334,) but no action was taken upon it during this session.

In the third session of the Fortieth Congress, Senate bill No. 622 came up in the House on the 10th of December, and was referred to the Committee on Roads and Canals. Considerable debate attended this action. (See Globe, third session, Fortieth Congress, pages 49, 50, 51, 52, 53, 54, 55.) On December 14, 1868, the House passed a resolution authorizing the committee to examine, under oath, skilled and scientific witnesses. (See Globe, page 75.) On March 1, Mr. Cook, of Illinois, introduced House bill No. 2014, which, in substance, was the same as Senate bill No. 622, in its modified form, and it was passed. (See Globe, page 1742.) It was referred, in the Senate, to the Committee on Commerce. (See page 1715.) No further action was taken, either upon Senate bill No. 622 or upon House bill No. 2014, and thus was presented the singular spectacle of bills for the same object being passed in each House, under different titles, and, in both cases, perishing in the committee-rooms.

In the third session of the Fortieth Congress, (Congressional Globe, page 1028,) February 9, Mr. Sherman introduced joint resolution No. 219, giving assent to the construction of the Newport and Cincinnati bridge. At the same time Mr. Morton introduced joint resolution (Senate report, No. 220) to prevent the building of any bridges over the Ohio with a central span of less than 400 feet. Both resolutions were referred to the Committee on Post-Offices and Post-Roads. On February 11, joint resolution No. 219 was reported, amended so as to require a span of 400 feet, and it was stated to be satisfactory to all parties. Mr. Morton added an amendment reserving the right to direct the necessary modifications and alterations of said bridge. The Senate then passed it, (Congressional Globe, page 1068.)

On March 2 the resolution was called up, by unanimous consent, by Mr. Cary, and passed without debate, (Globe, page 1809.) It is No. 21 of the joint resolutions which passed Congress at that session.

It is claimed, by those interested in the navigation of the Ohio River, and also by Representatives Moorhead, Eggleston, and Cary, who voted for the bill giving assent to the construction of the Newport and Cincinnati bridge, and to whom was specially intrusted the duty of preserving the free navigation of the Ohio River, that it was mutually agreed by all the parties in interest that the bridge should be as high as the Covington and Cincinnati suspension-bridge, viz: 103 feet above low water. As the bridge companies at Steubenville, Bellaire, and Parkersburgh all decided to build high and not draw bridges, although they had the option to do either, the public came to regard that part of the law of July 14, 1862, as a dead letter; and even when revived and extended to Cincinnati, where it is yet more inapplicable, they did not dream that, in the face of direct assertions to the contrary, the bridge company would adopt so objectionable an alternative.

The following statements from Representatives Moorhead, Eggleston, and Cary are made part of this history, as also the statement of the committee of the Pittsburgh city councils and Coal Exchange, who went to see the authorities of the Pennsylvania Central Railroad Company, in Philadelphia, to remonstrate against the manner in which this bridge was being built. The latter document shows that the constructors of the bridge acknowledge that the matter of raising it presents no engineering difficulties, but is merely a question of cost.

Statement of Hon. James K. Moorhead.

I, James K. Moorhead, of Pittsburgh, Pennsylvania, do state that I was a member of the Fortieth Congress from the twenty-second congressional district, Pennsylvania, and took a deep interest in the question of bridging the Ohio River; that the citizens of Pittsburgh and others, interested in the navigation of said river, did at different times send committees to Washington to represent the importance of maintaining the navigation of said river unimpaired and prevent obstruction to it by bridging the same; that during the winter of 1868 and 1869, such committee was there, composed of R. C. Gray, Joseph Walton, J. A. Blackmore, William H. Browne, and W. Milnor Roberts, with whom I had frequent conferences on the subject, and I have read a statement, dated Pittsburgh, November 4, 1870, signed by the four first-named persons, which statement I attach hereto:

"PITTSBURGH, *November* 4, 1870.

"We, the undersigned, hereby certify that we were a committee representing the river interests at Washington during the session of Congress, in 1868, and that our business there was to urge upon Congress the necessity for the passage of a general law for the bridging of the Ohio River, in such manner as to leave the navigation of the river safe and unobstructed. We claim that all bridges should have a main span over the channel of 500 feet in length, and a height of 40 feet above extreme high water. At that time we were aware of the fact that two bridges, one at Bellaire, and one at Parkersburgh, were in course of construction, and that these bridges were to have main spans of only 300 feet, [since made 350 feet.—Ed.,] and elevation of 90 feet above low water. The Baltimore and Ohio Railroad Company had representatives advocating these bridges. We met the late Judge Headington, of Cincinnati, who was there representing the Newport and Cincinnati Bridge Company, and he promised to us, on behalf of that company, that he would agree to make that bridge 400-foot span, and as high over the channel as the Cincinnati suspension-bridge, and that, if we would assent to this, we should have his influence and the influence of his company to aid us in having a general law passed to this effect. We were also to secure the influence of such members of Congress as we could control in favor of the passage of this law. Upon Judge Headington's repeated and solemn assurances, we called upon General J. K. Moorhead, the member from this district, and requested him to make no objection to the bill aforesaid. *We did this only on the solemn promise of Judge Headington that the Newport bridge would be built with a 400-foot span, and as high as the suspension-bridge, and that the piers would be so located as to leave the navigation safe.* Until recently we were of opinion and belief that this bridge was being built according to this agreement and understanding with Judge Headington. And we further state that the ridiculous proposition of a draw one hundred feet in width was never mentioned or referred to by Judge Headington or any one else.

"RICHARD C. GRAY.
"JOSEPH WALTON.
"J. A. BLACKMORE.
"WM. H. BROWNE."

That I believe the same to be correct and true, and recollect distinctly of one or more of said committee informing me that they had compromised with the bridge company upon a span of four hundred feet in length across the main channel, and in other respects satisfactory to them, and they desired me to make no opposition to the resolution when it reached the House. But, before the bill was called up in the House by General Cary, I learned that the act of July 14, 1862, was made applicable to it; and as this act permitted the alternative of a draw, and knowing, as I did, that a bridge constructed with a draw, and in other respects in compliance with that provision of the act, would be destructive to the interests of my constituents who were engaged in navigating the river, I determined to oppose it unless that part permitting a draw was stricken out. I made this known to General Cary, who assured me there was no intention of constructing the bridge with a draw; that the reference to the act of 1862 was to define the height; and, to give me assurance of this, he introduced me to a gentleman who represented the interests of the bridge company, Judge Headington, I believe it was, who assented fully to what General Cary had stated. I had no idea after that that a draw was contemplated by any person until I learned a few weeks since that one was actually being constructed.

Upon the assurances given me, I permitted the joint resolution to pass. It was called up on the 2d of March, 1869, (one day before close of the Fortieth Congress.) An objection or amendment offered at that time would have been fatal.

In further testimony as to the compromise made between the representatives of the bridge company and the committee from Pittsburgh, before referred to, I have a letter from Colonel W. Milnor Roberts, dated St. Louis, November 1, 1870, informing me that he was one of the committee who made the compromise; that they agreed to admit a span of 400 feet instead of 500, and were to have the aid and support of the bridge company or railroad men in establishing 400 feet as the minimum for the channel-span of all other Ohio River bridges.

That nothing was said about a draw; they all understood that it was to be the full height contemplated by the law for a bridge of continuous spans.

J. K. MOORHEAD.

PITTSBURGH, *November* 19, 1870.

Statement of Hon. Benjamin Eggleston.

I, Benjamin Eggleston, do state that I was a member of the Fortieth Congress, and took a deep interest in the question of bridging the Ohio River at and before the resolution of consent of Congress to the building the Cincinnati and Newport bridge; that I met Judge Headington there, who was representing the bridge company, and learned from him that a compromise had been effected satisfactory to the river interest, and that it had been agreed that the bridge should be built as high as the suspension-bridge at Cincinnati, with a span 400 feet long over the main channel. At his request I introduced him to the proper committee of the House, who were requested to report by him in favor of such a compromise. I further state that, except for such statement of Judge Headington and the belief in such compromise, no such resolution of consent could have been reported or passed. He further says that he has read over the statement of James K. Moorhead, to which this is attached, and the statement of Richard C. Gray and others, referred to therein, and he believes that these statements are true; and that the river interest yielded 100 feet in the length of the span over the main channel in consideration of the agreement that the bridge should be built as high as the suspension-bridge at Cincinnati.

BENJAMIN EGGLESTON.

Statement of Hon. S. F. Cary.

I, Samuel F. Cary, of Hamilton County, Ohio, state that I was a member of the Fortieth Congress from the second congressional district of Ohio. That I felt a deep interest in the subject of bridging the Ohio River; that I was an advocate of a 500-foot span, and nothing less. I further say that I was not induced to yield my opposition to the proposed bridge between Cincinnati and Newport until I was assured by Judge Headington, representing the bridge interest, and by those representing the river interests, and by telegrams shown me from Cincinnati Chamber of Commerce, (or officers thereof,) that a span of 400 feet across the channel would be satisfactory to all interests, provided the bridge was as high as the Covington suspension-bridge. It was late in the session, and I feared that the result of non-action by Congress might be attended with serious injury to the river interests, and I supported the resolution. But for the distinct understanding that the bridge was to be as high as the Covington suspension-bridge, and that the resolution was satisfactory to all concerned, I do not believe the resolution could have been passed, and I certainly would not have supported it. I have read the statement signed by the Hon. J. K. Moorhead, and the paper of Richard C. Gray and others, therein referred to, and say that, according to my recollection, they are substantially correct. I further say that the resolution of consent was reported upon the faith of a compromise being thus effected, by which the bridge was to be as high as the suspension-bridge, and of the pledge of the bridge company represented, as I understood by Judge Headington, that the bridge should be so built.

S. F. CARY.

CINCINNATI, *December* 3, 1870.

Statement of committee of Pittsburgh councils and Coal Exchange

The undersigned committee, appointed by the joint committee of the city councils and Coal Exchange of the city of Pittsburgh, to confer with Colonel T. A. Scott, vice-president of the Pennsylvania Central Railroad Company, in relation to the Cincinnati and Newport bridge, would beg leave to report that they met Colonel Scott, and asked him if the bridge could not be raised to the height of 100 feet above low-water mark, or to 40 feet above high-water mark. Colonel Scott said that he could not answer that question himself, but would call in Mr. Roberts, engineer, who was also vice-president of the company. Mr. Roberts, after some hesitation, said it could; that the method would be to raise the piers six feet higher, and to make the roadway over the top of the truss instead of the bottom, and raise the piers of the channel-span to the full height of the truss-work of the other spans, and construct the truss-work of the channel-span so that the road would be on the bottom chord, and thereby connect with the road running over the top of the truss-work of the other spans; but this change would cost considerably more money. Colonel Scott said the change could be made, but how would the means be raised? The committee stated that they did not come prepared to make propositions, but wished to hear from the Pennsylvania Central Railroad Company. Colonel Scott said if the city of Cincinnati would subscribe to the stock of the bridge, and issue city bonds for the amount necessary to make the change, the Pennsylvania Central Railroad Company would take the bonds and furnish the money. One of the committee suggested the method of raising the money required, by the bridge company issuing bonds, the same as they gave the Pennsylvania Central Railroad Company. Colonel Scott objected. It was then suggested that they issue second-mortgage bonds. Colonel Scott stated that the only acceptable way to raise the money would be by subscription to the stock of the bridge company.

In answer to the question, how would river crafts pass under the bridge in the high water, Colonel Scott said he had no doubt that the coal men would find means to pass through; said he would guarantee that if his friend Captain Bigley had a tow of coal above the bridge in high water, he would manage to get it through.

In answer to the question, what object had they in view for working night and day, also on Sunday, Colonel Scott stated it was to get the piers above water; that they were doing nothing that would not be required for a higher bridge. Colonel Scott treated the committee very kindly, and showed a disposition to do all in his power to remove the present objections to the bridge, provided the means could be raised to make the changes without expense to the Pennsylvania Central Railroad Company, and also stated that they would take up the matter at once and make the estimate of the additional cost, and correspond, without delay, with the committee.

SIMPSON HORNER.
N. J. BIGLEY.
CHAS. A. DRAVO.
HILL BURGWIN.

OCTOBER 27, 1870.

DESCRIPTION OF THE SUBSTRUCTURE OF THE NEWPORT AND CINCINNATI BRIDGE AND APPROACHES—EFFECTS UPON THE CURRENTS OF THE RIVER—CHARACTER OF THE WORK, AND ESTIMATE OF ITS COST.

As the location of the 400-foot span is the controlling feature in the structure, so far as navigation is concerned, we will begin with it, and refer to other governing features as they arise in the progress of description, premising that the position of the bridge itself was determined by the desire to make the least expensive location for connecting two railroads on opposite sides of the river. On the drawings of the bridge company the piers are numbered from the Ohio shore, so that pier No. 1 is next to the abutment on the Cincinnati side, and the others are numbered regularly across to the Newport side. In describing them we will use the same numbers.

The pier on the Cincinnati side of the main channel (pier No. 3) has its center-line about 50 feet south of the low water line, and in a depth of 2½ feet at low water. The pier on the Newport side of the channel (pier No. 4) has its center-line 418 feet from that of pier No. 3, in 3½ feet at low water, and about 310 feet from the low-water line on the Newport side. This location of the 400-foot span leaves the main low-water channel between them, with a depth at low water of about 6 feet. No special examinations were made by the bridge engineers to ascertain the depth to solid rock at different points, and the pier locations were made without regard to it, though we have reason to believe that piers 4, 5, and 6 have their foundations within 2 feet of the solid rock. The tops of the channel-piers are finished with three courses of cut stone, each projecting a little from the course below, and the three courses together being 4 feet thick. The upper surface, which receives the end-posts of the trusses, is 73 feet above low water. The batter of the piers begins below the three top courses, where the piers are 10 feet wide and 69 feet above low water, and extends down to within 6 inches of low water. This batter or slope of the sides is the same for all the piers, and is 24 upon 1. At the foot of each pier, 6 inches above low water, there is an offset of 6 inches on each side, and a course of stone 1⅔ feet thick; then another offset of 6 inches, and another course of stone of 1⅔ feet thickness; then another offset of 6 inches, and a course of stone 1⅔ feet thick; and finally a timber grillage of three courses of poplar timber, each 1 foot thick, projecting 1½ feet beyond the masonry. In no case does this timber foundation rest upon the rock.

The width of these piers 6 inches below the low-water line is therefore 17¾ feet. The direction of the axis of the bridge along which the span of the trusses is measured is not, during any stage at which we have measurements, at right angles with the river current, and consequently the piers, which are at right angles to the axis of the bridge, are not parallel with the current of the river. The line of direction of the current does not materially vary from low water up to a stage of 10 feet above low water, and during these stages the piers are 12° out of the line prescribed by law.

The length up and down stream of the channel-piers, at their bases, is about 58 feet, and therefore their want of parallelism with the current contracts the water-way space between them by 10 feet, leaving a practicable opening of about 390 feet.

The foundations of the channel-piers are very defective. The bottoms of the wooden platforms are between 4½ and 5 feet below low water, while the depth at low water between these piers is 6 feet now, and probably, owing to the contraction of the water-way, this depth will be much increased by the scour of high water. These foundations are, therefore, apparently insecure. At present they are somewhat protected by riprap and by the coffer-dams used in their construction, which have not yet been removed. To secure them it will probably be necessary to greatly increase this riprap. These foundations are similar to those at the Steubenville bridge, where the riprap occupies at least 40 feet of the channel-way between the piers. Such a protection here (and it would be unsafe to make a less effective one) would reduce the space between the channel-piers available for navigation by not less than 40 feet, except at stages of the river high enough to submerge the riprap several feet. It is possible, however, to protect these piers without materially obstructing the navigable channel, but it would be somewhat expensive.

The want of parallelism of the piers with the current arises from the Cincinnati end of the bridge being thrown above the Newport end, to facilitate connection with the Little Miami Railroad. The law says "the piers of said bridge shall be parallel with the current of the river as near as practicable." Some persons have contended that this meant as near as practicable to suit the approaches to the bridge; but obviously this cannot be the case. The opening designated was for the benefit of the navigation of the river, and to admit any impracticability in the approaches as governing the case might operate almost indefinitely to the detriment of navigation. We can imagine a case of a bridge crossing so obliquely as to reduce by one-half the space practicable for navigation. If the site selected for the bridge be such that it really is impracticable to make the bridge at right angles to the current, it is obviously the duty of the company either to lengthen their spans so as to secure the navigable width that the law requires, as was done in the case of the Keokuk bridge, or else to select some site where they can comply with the law. There was no absolute necessity of this bridge crossing at Saratoga street, as better sites could have been found higher up the river. The company selected this site on account of certain supposed pecuniary advantages, and if these advantages are greater than the extra cost of complying with the law, they should not complain at having to do so. If they are not, they should go elsewhere to build their bridge.

The plain meaning of "parallel as near as practicable" is this: The current almost everywhere in the river has different directions at different stages. It is thus impracticable to build piers that shall always be parallel with the channel. Such a location for the piers must be made as is parallel to the average of the directions of the current at all stages, or parallel to the current at that stage of the river when such condition is most important to navigation. If the variation in direction is great, the bridge should be built somewhere else. The effect of this obliquity of the piers of the channel-span is to make the current set upon the one on the Newport side, and, owing to the shape of the bend in the river above the bridge, this increases as the river rises. At low water this span is undoubtedly over the main flowage of the river; but, from half to full stage, at least half the flow must be on the Newport side of it.

The navigation interest therefore complain, and with reason, that the Newport channel-pier is practically in the main navigable channel.

Before discussing the height of the channel-span, it is best to finish up with the locations and directions of the other piers, continuing toward the Newport side.

From the center-line of the Newport channel-pier to the center-line of the next pier on that side (No. 5) is 237 feet, leaving a clear span of 220 feet, and then comes the draw-span. Some of the river men think that the draw-span would have been better next to the channel-span. But the law approved July 11, 1862, provided that "one of the next adjoining spans shall not be less than 220 feet in length," and as it was inconvenient with the location given the channel-span to make a 220-foot span next to it on the Cincinnati side, as will be seen when we describe that side of the bridge, the 220-foot span was placed on the Newport side, and the draw-span pushed that much further toward that side.

Pier No. 5 is parallel to pier No. 4, makes the same angle with the current, has the same defective foundations, requiring riprap, and differs from it only in being 2 feet narrower on top, and in being made a rest-pier for the end of the draw when not open.

This drawbridge differs materially from any constructed on the western waters with which we are acquainted, and it is impossible to describe it in a few words. The law requires that it shall be constructed "with spans of not less than 100 feet in length on each side of the central or pivot pier of the draw." It was designed at first to make it exactly so, but this span was increased 1 foot each side of the pivot-pier from the following cause: Both of the rest-piers were commenced before the pivot-pier. In sinking the foundations for the second rest-pier, the coffer-dam settled somewhat further from the one first built than was intended. The pivot-pier No. 6 was therefore placed midway between these two piers, and therefore the span on each side of the pivot was somewhat increased. As built, the centre-lines of the two rest-piers (No. 5 and No. 7) are 260 feet apart, or 130 feet from the center of the pivot itself. The rest-pier, No. 7, on the Newport side of the pivot, is built like pier No. 5, already described, and parallel with it, making the same angle, 12°, with the current. The distance between these two piers at the low-water line is 260 feet, diminished by 16⅞ feet, or 243⅛ feet. The pivot-pier has a circular horizontal section, 42¼ feet diameter at low water, so that the space left each side of it is 100½ feet at the low-water line. Like the others, it rests upon a timber grillage, and, like them also, it will require riprap protection.

The protection-pier or pivot-guard, placed above the pivot to protect it from ice, and to make a rest for the draw when open for navigation, is not placed so as to form a long pier at right angles to the bridge with sides parallel to the other piers, but is placed parallel to the present direction of the current. The consequence is that the upper end of the rest-pier on the Cincinnati side of the draw projects into the draw-space about 7 inches, and the lower end of the pier on the Newport side of the draw projects 5 inches. This not only diminishes the space, but it presents to the navigator a very ugly and dangerous appearance. The end of the protection-pier is placed about 185 feet above the pivot, and consists of a sawed timber crib filled with stone. It does not extend to the pivot, but stops 118 feet from it, where it forms a rest for the draw when open. The space between this protection-pier and the pivot proper is occupied by a crib filled with stone up to 10 feet above low water; and above this by a float made of framed timber, which rises when the water reaches it, and is guided and kept in place by projections on the pivot and protection piers. It is designed to direct boats and floating objects through the open space, and to prevent them from striking the end of the draw-bridge when open. At low water there is no water in the Newport draw-space and but little in half of the other. No design has yet been made for a rest and protection-pier *below* the pivot. All the draw-bridges built on the Mississippi have them, and they seem essential to the security of the bridge.

Pier No. 8 is 8 feet wide on top, and its center-line is 202¼ feet from that of No. 7. It stands on the river bank, and has the same kind of timber foundation, placed in an excavation of 15 feet, the bottom being at the level of low water, at which depth compact gravel was found.

Pier No. 9 is 7 feet wide on top, and has its center-line 202¼ feet from that of No. 8. Its foundation consists of 2 feet of concrete, resting on sand, about 16 feet below the natural surface, and 27½ feet above the low-water line.

The Newport abutment is so placed that the space between it and pier No. 9 is 125¾ feet, which brings it on Saratoga street, south of the river bank. The truss from this abutment to the pier is 132 feet long, and crosses Front street of Newport.

The descent toward Newport of the wagon-road begins at pier No. 9, along the bottom chord of the span connecting it with the Newport abutment; and thence on brick arches, on a grade of 5,637 to 100, reaching the level of Saratoga street at Market street, about 180 feet from the abutment.

The railroad descent on the Newport side, which has a grade of 0.2393 to 100, also commences at pier No. 9, and continues beyond the abutment, over brick arches, turning about 1° to the right at Taylor street, in order to keep along Saratoga. Market street is crossed by a bridge of 58 feet span, 14 feet above the street, and the city grade is reached at Southgate street, about 750 feet from the abutment. No street of Newport is stopped by the approaches for either the wagon-road or the railroad.

We will now complete the description of the substructure by returning to the Cincinnati side of the channel-span. The channel-pier on that side, pier No. 3, has already been described.

Pier No. 2 has its center-line 137.4 feet from that of pier No. 3. The reason for making this span so short was in order to begin a curve near this pier for the railroad connection with the present Little Miami depot. Long spans on a curve are very objectionable, and hence, as mentioned before, the 220-foot opening was placed on the Newport side of the channel-span. This span, however, could have been made 237 feet, without changing the curvature, by placing the channel-pier 100 feet further from the Cincinnati shore, but this would have required the Cincinnati channel-pier to have been built in water 3½ feet deeper . It would, however, have made the channel-span much better for navigation. Had pier No. 2 been placed 100 feet nearer the Cincinnati side, the curvature of the railroad connection would have exceeded 10° if the line itself remained unchanged. The curvature is already as great as is allowable. Pier No. 2 has the same grillage foundation as the others, resting on compact gravel at about the level of low water, and excavated about 12 feet below the present natural surface. It is 8 feet wide on top, and has the batter of 24 upon 1. The wagon-road approach begins to descend from this pier along the bottom chord of the next span.

Pier No. 1 has the middle point of its center-line 96¼ feet from the corresponding point of pier No. 2, but its center-line being a radius of the curve of the railroad connection, makes an angle of 4° with No. 2, and consequently of 16° with the course of the current. Its foundations are at the level of low water, and consist of a wooden grillage, 3 feet thick, resting on compact gravel 25 feet below the present surface of the ground. The pier is 5¾ feet wide on top, and five feet lower than the others, owing to the descent of the bottom chord of the trusses, in order to accommodate the wagon-road approach.

The Cincinnati abutment is the same distance from pier No 1 that the latter is from No. 2. It is so far back on the levee that it will not obstruct the flow of any high water not already stopped by buildings. The wagon-road approaches continue to descend from the bridge at the rate of 5.637 to 100, reaching the city grade at Front street, 175 feet from the abutment.

The railway continues for 100 feet on a curve, with 609 feet radius, supported by two brick arches rising between the two wagon-way approaches; then comes a span of 100 feet, built on this same curve, under which the two wagon-way approaches unite. The curve continuing, the railroad now crosses Front street by a bridge of 100-foot span, and about 14 feet in height above the street. The grade of the railroad has been descending from pier No. 2 at the rate of 0.435 feet per 100, on a curve of 609 feet radius. The grade now changes to 0.8 to 100, on a radius of 573, which continues for 450 feet. At the point where this change in grade and curvature takes place, wooden trestles begin.

The railroad grade continues to descend at 0.8 per 100 on a tangent, crossing Eggleston avenue and Kilgour street until the level of the track at the Little Miami freight-depot is reached.

Eggleston avenue is completely blocked up, as the railroad grade is only from 8 to 9 feet above the grade of the avenue, and consequently there is not sufficient head-room for a bridge. At the crossing of Kilgour street the surface of the latter was raised 4 feet.

The effect of the piers in contracting the water-way is as follows: The entire area of the natural river section at the stage, 6 feet above low water, the stage at which we observed, is 10,875 square feet. The piers, as they now are, with the piling around them, occupy 4,100 square feet, leaving 6,775 square feet of water-way. The mean velocity at that time is about 2,594 feet per second, and the discharge about 30,240 cubic feet per second. At this stage only piers Nos. 3, 4, 5, 6, and 7 stand in the water. At dead low water, only piers Nos. 3, 4, 5, and 6 are in the water-way, and they then obstruct an area of only 1,308 square feet, so that their effect is then inconsiderable.

The highest water observed in a period of twelve years, during which we have a continuous record, is 57½ feet above low water. During this period the water has five times been up to, or above, a stage of 55 feet above low water.

The area of the natural section at the stage 55 feet above low water is 79,880 square feet; and about 980 square feet of this is obstructed by a wall just above the bridge, built by the iron-works of Gaylord & Co., Newport. The portion of this section occupied by the piers, and the piling around them at this stage, is 9,788 square feet, equal to 12.4 per cent. of the whole. Should the bed of the river hold firm, these obstructions would cause an increase of the mean velocity at high water of 12.4 per cent.; or if we suppose the maximum velocity at this stage of water to have been six miles an hour, it will now become six and three-fourth miles per hour.

Judging from experience elsewhere, this increased velocity will, in all probability, so increase the scour as to restore the section to its former area, if the bed be not protected by riprap; and will so endanger the present foundations as to render extensive protecting riprap work around their bases a permanent necessity.

The greatest flood ever noted at this place was that of 1832, when the river rose 62¼ feet above low water. At that date the natural channel had not been interfered with to any extent. It is difficult to estimate what would be the effect of such a flood with the bridge built as now designed, with the river narrowed, as it has been, by encroachments immediately above. The permanency of the bridge under such a visitation is questionable.

The piers are all finished at the top with three courses of cut stone, each course about 1 foot thick, and each projecting slightly from the course of stone below it. At the distance of 23 feet from the top, there is a band of cut stone 15 inches thick, projecting 5 inches.

The stone between this band and the three topmost courses is a sandstone, sustaining a crushing weight of 11,137 pounds per square inch. The same stone is used as backing to the courses below the projecting band, but all the outside stones below this band are limestone, a material superior to the other in resistance to pressure and wear. The masonry is all laid as range work, in courses from 15 inches to 2 feet thick. The batter is generally 24 upon 1, the stone preserving its quarry face, except at the upper starlings, which are dressed off smooth. Piers Nos. 3 and 4 are 10 feet wide and 25¼ feet long on top. Piers Nos. 2, 5, 7, and 8, are 8 feet wide and 21¼ feet long on top. All these piers are rectangular on top, and the horizontal section continues of this shape down to the projecting band, 23 feet from the top, where the starlings are reached.

The down-stream starlings have semi-circular horizontal sections, and so has the up-stream starling of pier No. 1. All the other up-stream starlings are composed of two plane faces, meeting so that the angle of the horizontal section is 67½°, and the angle of the line of intersection of these faces, or the cut-water, has a slope of about 4 upon 1. Pier No. 1 differs from the foregoing in having its top 5 feet lower, and in being on top but 5¾ feet wide and 21½ feet long.

The pivot-pier is circular, and built of the same kind of masonry as the others. Its diameter on top is 36 feet, but it is 6 feet lower than the others, to leave room for the drum and turning arrangements. It is not solid, but four openings or wells were left, in order to save masonry. There is no protection-pier or other work below it. The protection-pier or pivot-guard above it is a crib of sawed timber filled with stone. It is placed just near enough to the pivot-pier to support the end of the draw when open, and the space between them is occupied by a framed timber float, rising and falling with the river, and serving as a guide to passing boats and floating objects, so as to keep them from hitting the pivot or bridge. The cut-water of this protection-pier is formed in the same shape as the up-stream starlings of the other piers. The wooden nose is to be protected with iron. The protection-pier at the bottom extends 187 feet above the center line of the bridge. It is an inferior kind of a structure, and being of wood, will not be as permanent as such work should be.

The foundation of pier No. 9 rests on 2 feet of concrete, which is laid on sand. All the other foundations consist of three courses of timber, of 1 foot each in thickness.

We have received the following account of the work of laying these foundations:

The pier foundations were commenced in August, 1869, and piers Nos. 1, 2, and 7 were put in before the close of the season. These were out of the water, and only required simple excavations. During the same time the coffer-dam at No. 5 was commenced. This was a double frame filled with puddling. Work was continued on the coffer-dam until high water stopped operations. In the spring of 1870 the programme was changed, and the coffer-dams used were constructed of sheet-piling 4 inches thick, put down in single rows and calked, the lower ends of the piles being shod with iron. They were put in place, and puddling of mud, &c., piled about the foot on the outside to a height of about 10 feet, with the natural slope. This was found not to accomplish the object of keeping out the water, until the entire bottom, on all sides for a distance of 75 feet, was covered, to the depth of 3 feet, with clay, and an embankment of clay was built up on the outside to the surface of the water. The work of excavation was carried down through the gravel bottom of the river, to the rock in place at pier No. 3, and to heavy limestone boulders, supposed to rest on the rock at the other piers. It was found impossible to excavate to the rock in place by the method pursued. Pier No. 3 was put in while the water was 9 feet above the zero of the water-works. Piers Nos. 5 and 6 are thought to be within 3 feet of the rock. It is thought that a much cheaper and better method of building these piers would have been to dredge out the place for the foundation, and to lay the masonry in caissons. A permanent protection to the foundations remains to be made. The space around each pier should be covered with riprap for a width of 40 feet; under no circumstances coming higher than 3 feet below low water. No stone should be used of less size than two perches, or 50 cubic feet, and they should be laid in contact and well fastened together.

The material in the bed of the river, in the order in which it is met, is one foot of coarse sand with small boulders, two feet of coarse gravel, and then flat stones, that seem to have once been in motion along the bed of the rock beneath.

The brick-work of the approaches is of medium quality, trimmed in part with stone. The foundations of the arches, in some cases, seem to have yielded, causing cracks. Some of the bricks will be submerged in high water, a test to which its quality does not well adapt it.

The wooden trestle-work of the railroad approach on the Cincinnati side is of the ordinary kind, and is temporary in its character.

The following estimate of the cost of the substructure, on the present plan, we have made ourselves, with as much care as possible, having failed to get any such information or estimate from the bridge company:

Pier No. 1. Excavation for foundation above water, 490 cubic yards, at 75 cents	$368 00	
Timber grillage, 1,600 cubic feet, at 30 cents	480 00	
833 cubic yards masonry, including cut stone, at $18	14,994 00	
		$15,842 00
Pier No. 2. Excavation for foundation above water, 540 cubic yards, at 75 cents	405 00	
Timber grillage, 2,880 cubic feet, at 30 cents	864 00	
1,160 cubic yards of masonry, including cut stone, at $18	20,880 00	
		22,149 00
Pier No. 8		22,149 00
Pier No. 3. Preparing and placing foundation	7,500 00	
3,843 cubic feet of timber for grillage, at 30 cents	1,153 00	
Riprap protection of large blocks, clamped	7,500 00	
1,290 cubic yards masonry, including cut stone, at $18	23,220 00	
		39,373 00
Pier No. 4		39,373 00
Pier No. 5. Preparing and placing foundation	7,500 00	
Riprap protection	4,000 00	
Excavation for foundation above water, 540 cubic yards, at 75 cents	405 00	
Timber grillage, 2,880 cubic feet, at 30 cents	864 00	
1,160 cubic yards of masonry, including cut stone, at $18	20,880 00	
		33,649 00
Pier No. 7		33,649 00
Pier No. 6, or pivot-pier:		
Preparing and placing foundation	12,000 00	
7,700 cubic feet of timber for grillage, at 30 cents	2,310 00	
Riprap protection of large blocks, clamped	10,000 00	
2,500 cubic yards masonry, including cut stone, at $18	45,000 00	
432,000 feet, board measure, of timber, in crib of pivot-guard, framed and bolted, at $40	17,280 00	

3,100 cubic yards stone for crib, at $1 50	$4,650 00	
8,000 pounds iron plate for sheathing to ice-breaker, at 10 cents	800 00	
54,000 feet timber for guide-float, at $40	2,160 00	
		$94,200 00
Pier No. 9. Excavation for foundation above water, 360 cubic yards, at 50 cents	180 00	
30 cubic yards concrete foundation, at $6	180 00	
360 cubic yards masonry, including cut stone, at $18	6,480 00	
		6,840 00
Total cost of piers		307,224 00

Approach for railroad and wagon-road on Newport side from main abutment on Market street:

578 yards stone masonry, at $18	$10,404 00	
718 yards concrete, at $6	4,308 00	
486 yards brick-work, at $15	7,290 00	
240 yards Macadam stone, at $2	480 00	
Bridge for railroad of 58-foot span	3,000 00	
		$25,482 00

Approach for railroad in Newport between Market and Southgate streets:

200 yards stone masonry, at $18	3,600 00	
300 yards concrete, at $6	1,800 00	
180 yards brick-work, at $15	2,700 00	
82 yards Macadam stone, at $2	164 00	
Grading and paving streets	500 00	
772 feet rails, 257¼ yards, (at 60pounds per yard)=15,440 pounds, at $85 per ton	656 00	
193 ties, at 50 cents	96 00	
		9,516 00
Total cost of approaches on Newport side		34,998 00

Cincinnati approach for railroad and wagon-way from abutment to Front Street:

1,994 yards stone masonry, at $18	$17,892 00	
428 yards concrete, at $6	2,568 00	
1,007 yards brick-work, at $15	15,105 00	
142 yards Macadam stone, at $2	284 00	
Railroad bridge over wagon-way, 84-foot span	5,000 00	
		$40,849 00

Cincinnati Railroad approach from Front street to Little Miami depot:

Bridge for railroad over Front street, 84-foot span	5,000 00	
120 cubic yards masonry abutment, at $18	2,160 00	
20 cubic yards concrete, at $6	120 00	
64,000 feet lumber in trestles, framed and erected, allowing for only single track, at $35	22,400 00	
1,000 yards embankment, at 50 cents	500 00	
2,000 feet of road, requiring 1,333⅓ yards of rails, at 60 pounds per yard=80,000 pounds, at $85 per ton	3,400 00	
1,000 ties, at 50 cents	500 00	
		34,080 00
Total cost of approaches on Cincinnati side		74,929 00

Recapitulation.

Total cost of piers	$307,224 00
Total cost of approaches on Newport side	34,998 00
Total cost of approaches on Cincinnati side	74,929 00
Grand total	417,151 00

DESCRIPTION OF THE SUPERSTRUCTURE OF THE NEWPORT AND CINCINNATI BRIDGE, AND ESTIMATE OF ITS COST WHEN COMPLETED ACCORDING TO PRESENT DESIGN.

The charters of this bridge, obtained from the legislatures of Ohio and Kentucky, leave it optional with the company to construct any kind of bridge which they may select that will not obstruct the navigation of the river more than is authorized by the laws of the United States.

The ordinance of the city of Newport, granting the use of portions of the streets for the purpose of a bridge, makes one of the terms of the grant that said bridge shall be constructed and used for "the passage of vehicles and foot-passengers across the Ohio River, and for railroad purposes." It therefore became necessary, if the bridge was to be built within the limits of the city of Newport, to construct it as a combined wagon and railway bridge. The trusses are being built by the Keystone Bridge Company after their usual designs.

The plan of superstructure adopted is to place the two trusses so close as to allow a clear space of 13 feet for the passage of trains. This is the very least that will admit the largest-size passenger-cars capable of using the Little Miami gauge of 4 feet 8½ inches.

The floor-beams are of iron, suspended generally from the lower ends of each post, and projecting each side of the truss so as to permit of a wagon-way 6 feet wide, and a sidewalk 3 feet wide, the space outside of the trusses being 10½ feet. The superstructure is thus 38½ feet in width over all. The railroad-track rests on the suspended iron floor-beams, except for two spans on the Cincinnati side and one span on the Newport side, in which spans the railroad-track is supported on separate floor-beams, intermediate between the top and bottom chords. These spans are further peculiar in having a horizontal top chord, with the lower chord on the grade of the wagon-road approaches, to wit, on a slope of 5,637 feet to 100.

The tops of the piers are 73 feet above low water, but as the floor-beams are 1½ feet deep, suspended below the bottom chord, there is left an unobstructed headway of 71½ feet.

The drawings which we have received show the proposed arrangement of the first two spans on the Cincinnati side. The trusses already erected over the space between piers Nos. 7 and 8 show us what that span is to be. We have also been furnished with drawings of the pivot or draw span. Thus far we have not been informed of the moving load the bridge is designed to support. It is probable, however, that an allowance of load equal to 2,500 pounds per lineal foot of the railroad, and 100 pounds per square foot of the wagon-road, and 75 pounds per square foot of sidewalk, has been provided for. The load to be sustained outside of the trusses is, therefore, about 1,575 pounds per lineal foot, making the total of the moving load 4,075 pounds per lineal foot. The width of roadway and sidewalk is very small, and the arrangement for wagon-way alongside of the railway is very objectionable. The sum of the weights of roadway bearers for both kinds of roads, longitudinal beams, railroad ties and rails, wagon-road floor, and hand-rails, is about 1,000 pounds per lineal foot of bridge. From these we obtain the proper elements for calculating the dimensions of the trusses required for supporting these permanent and rolling loads. The bridge company not having furnished us with any statement of the cost of making the trusses, we have made out calculations on the basis of the cost of the bridges heretofore built by the Keystone Bridge Company, and have allowed market rates for the kind of work required.

The following is an estimate of the cost of the superstructure, as now being built, from abutment to abutment, a distance of 1,782½ feet:

Estimate of cost of superstructure of bridge, as being built, including roadways, rails, side-rails, &c., complete.

One span of 418 feet, out to out	$160,000 00
One draw-span, 260 feet	38,000 00
Apparatus for turning	7,000 00
One span, 237 feet	48,000 00
Two spans 02½ feet each, at $39,500	79,000 00
One span, 137½ feet	13,500 00
One span, 132 feet, including bottom chord and double roadway bearers.	16,000 00
Two spans, 96 feet, including bottom chord and double roadway bearers.	14,000 00
Total	375,500 00

EFFECT WHICH THE BRIDGE, AS NOW BEING CONSTRUCTED, WILL HAVE UPON THE NAVIGATION OF THE OHIO RIVER.

The objections urged by those interested in the navigation of the Ohio River against the Newport and Cincinnati bridge, are as follows:

1st. That the bridge is too low.

2d. That the character of the commerce of the Ohio River is such that no draw-bridge can be made at Cincinnati that will not seriously obstruct navigation.

3d. That the channel-span is so located that it is difficult to reach and dangerous to run.

The question of the proper height for a bridge at Cincinnati to connect that city with Covington was agitated for many years, and the existing suspension-bridge is the result of a compromise between the interests involved. For a long time the river-men would not agree to a less height than 125 feet, with a span equal to the average width of the river. As a bridge of such great height could not be built with practicable grades for vehicles without excessive cost and limited usefulness, a compromise was finally effected, in accordance with which the present structure was erected, with a height of 103 feet at the crown and a clear span of 1,000 feet. But even this bridge is somewhat of an obstacle, as in high water the larger-sized steamers cannot pass under it, and the velocity of the current is perceptibly increased by the contraction of the water-way by its two piers. But the river interest concedes the fact that it must submit to some inconveniences for the general public good, and the compromise which resulted in the erection of this suspension-bridge has been generally accepted as equitable to all parties. The result is that the bridge has been taken as the boundary between the up-stream and the down-stream traffic, one class of boats having permanent landings above the bridge and the other below.

Comparing this bridge with that now being built between Newport and Cincinnati, we find that the latter is 31½ feet lower, with a maximum channel-span of 400 instead of 1,000 feet.

The Newport and Cincinnati bridge is 71½ feet above low water, or 9 feet above extreme high water, the maximum difference between high and low water at Cincinnati being 62½ feet. It is manifest that in extreme high water nothing but low flats or rafts could pass under the bridge.

In order to show what depth of water may be expected at Cincinnati, we have carefully compiled the following table from the official records of the city, as kept at the water-works office, since the 1st of June, 1858, being taken twice each day, and covering a period of over twelve years. The heights given are those above the official "O," which shows dead low water, at which time there is 1½ feet of water on Four-mile Bar above, and on Rising-Sun Bar below. The figures show the number of days in each month during which there is in the river the specified number of feet above low water:

River-record at Cincinnati.

Month, &c.	Height in feet above low water.										
	5	10	15	20	25	30	35	40	45	50	55
January	31.0	30.5	25.0	19.7	13.0	8.3	6.5	2.7	1.8	1.2	0.4
February	28.0	27.5	25.0	18.2	12.8	9.0	8.8	3.2	1.2	0.2	......
March	31.0	31.0	29.3	27.0	21.6	14.7	10.5	5.4	3.5	1.8	0.8
April	30.0	30.0	29.0	26.6	18.2	11.8	8.3	4.5	2.1	0.1	0.1
May	31.0	30.1	22.8	14.0	8.0	5.5	3.3	1.2	0.8	0.3	0.2
June	29.5	23.2	11.8	4.7	2.3	1.5	1.0	0.3	......	......	......
July	29.6	12.1	4.6	1.4	0.4	......	......	......	......	......	......
August	26.6	7.8	1.9	......	......	......	......	......	......	......	......
September	19.9	10.1	5.9	2.3	1.3	1.2	0.6	0.3	......	......	......
October	22.0	9.1	4.8	2.4	1.3	0.7	......	......	......	......	......
November	17.0	15.1	10.1	5.9	2.7	0.6	0.3	0.2	......	......	......
December	30.3	26.3	21.3	10.2	8.8	5.3	2.3	0.8	0.1	......	......
Average number of days in each year	325.9	252.8	191.5	132.4	90.4	58.6	41.6	18.6	9.5	3.6	1.5
Space under bridge .... feet	66½	61½	56½	51½	46½	41½	36½	31½	26½	21½	16½
Space available .... feet	65	60	55	50	45	40	35	30	25	20	15

When the river at Cincinnati is 5 feet above low water, there is 5 feet on the bars above and below. When there is 10 feet, the same bars show 9 feet of water, and at 15 feet by the water-works marks, they can be crossed by boats drawing 12 feet. As they are the ruling bars for long distances above and below, the depths on them show the capacity of the river at these stages. A good coal-boat rise of 8 feet at Pittsburgh generally gives from 12 to 20 feet at Cincinnati, depending upon the time of the year.

The last two lines of the table show the absolute space under the bridge at these stages, and the greatest available space, allowing 1½ feet for clearance, which is the least margin that could safely be taken.

The dimensions of some of the largest packets, at present regularly employed on the river above Cincinnati, are as follows:

Dimensions.	Fleetwood.		Telegraph.		St. Charles.	
	Feet.	*In.*	*Feet.*	*In.*	*Feet.*	*In.*
Length	260	00	251	00	273	00
Width over all	70	00	68	00	70	00
Top of cabin above water	29	00	29	00	26	2
Top of texas	34	00	34	3	34	6
Top of pilot-house above water	48	00	4	3	47	00
Top of chimneys above water	75	00	77	00	68	00

The Fleetwood and Telegraph are regular up-river packets, running to Pomeroy and the Big Sandy. The record shows that during one hundred and fifteen days in each year the former could not get under the bridge, even with lowered chimneys, and that the latter would be similarly stopped during one hundred and nine days. The St. Charles is a regular Pittsburgh and Cincinnati packet, and she would be compelled to use the draw during one hundred and seven days. Without lowering their chimneys none of these boats could get under the bridge at all, as those of the first two are higher than the bottom chord of the bridge at dead low water, and the latter, whose chimneys have lately been shortened 8 feet, could only get under the bridge at a stage of water when she could not run at all. The Juniata, St. Mary's, and Arlington, the consorts of the St. Charles in the Pittsburgh and Cincinnati Packet Line, are all side-wheel steamers of about the same size. There are other packets as large, and others somewhat smaller, that regularly or occasionally ply up the river, but those mentioned are about the largest.

The tops of the chimneys, when lowered as at present arranged, come about 6 feet above the pilot-houses, in order to secure leverage for the shears when raising them into place, and in order to get the smoke out of the eyes of the pilot at the wheel. But it is believed that they can be still further lowered by improved mechanical appliances, and that the pilot-houses may be moved sufficiently forward to get out of the smoke. The mere lowering of the chimneys of a first-class boat, some of which are 5½ feet in diameter, is a job of considerable difficulty, not unattended, at times, with danger.

The position of the pilot-house of a western steamer is a matter of great importance, in order that the pilot may see the water as near the bow and stern and sides of his boat as possible. The most elevated position practicable is also required, in order to see distinctly the water-surface, which, to the trained eye, indicates with great precision the outlines of shoals, sunken rocks, wrecks, and snags. In the Missouri River, where the channel changes every two weeks, pilots run entirely by the appearance of the water, and the higher they are above it the more clearly they can see and interpret its variations. Then, again, western rivers are often covered with dense, low-lying fogs, which are impenetrable at the level of the main deck, but often do not rise to the height of the pilot-house. Long experience has shown the necessity of the high pilot-house, and it cannot be lowered without great injury to navigation.

However inconvenient and dangerous the draw may be, yet individual boats can get through it in some way or other, though not without both delay and danger. It is very narrow, only 100 feet in width, being 60 feet less than that prescribed by Congress for the bridges over the Mississippi, and the cross-currents formed in so contracted an opening by the deflection of the current from the pivot-guard and by the obliquity of the piers, will make its passage very hazardous. Moreover, the narrowness of the water-way at Cincinnati, which causes the exceptional height of high water, also greatly increases the surface velocity, making the passage of narrow places more dangerous than it would be at any other point on the river.

No boat would dare attempt to get through from above without rounding to and backing, and, if possible, getting a line to the pivot-guard and letting itself drop through. This is a delicate operation, even in day-time, as the guard-pier is so near the pivot-pier, but at night it is almost an impracticable one. Most captains and owners had sooner tie up above the city until morning rather than risk their boats by a night passage of this draw.

Such losses of time are serious losses of money, and the annoyances to passengers thus stopped while almost at their journey's end would appreciably affect the river-travel. But there is a large and increasing class of traffic on the Ohio River, to which the draw is almost an impassable barrier when the river is too high to pass under the bridge.

It is a great mistake to imagine that the river commerce has been killed by railroads. The latter have undoubtedly taken away all the passenger traffic except for river towns that cannot otherwise be reached. But in the mean time the freight traffic, especially in coal, has increased enormously. Pittsburgh alone shipped last year to Cincinnati and towns below 48,000,000 bushels of coal; and the trade increases from year to year. Other points below Pittsburgh ship largely of coal and salt; and Pittsburgh, Steubenville, Wheeling, and Pomeroy send down large quantities of manufactured iron, receiving, in return, nearly equal quantities of iron ore from Missouri. The total amount of coal that at present passes the site of the Newport and Cincinnati bridge is estimated at 75,000,000 bushels.

All of these heavy products are carried in barges made up into fleets of from two to twenty, propelled and guided by powerful tow-boats. Coal-barges are 24 feet wide and 130 feet long, each one carrying about 12,000 bushels. Coal-boats are from 25 to 26 feet wide and 168 to 173 feet long, with a capacity of 22,000 bushels. The former draw, when loaded, from 5 to 6 feet, and the latter about 8. The towing interest is now the greatest on the river, and it is the one that all river improvements are designed to accommodate, and the one which builders of bridges should especially strive not to injure. Single packets, except in the matter of height, can always go wherever coal-fleets can, and therefore the interests of the latter need special consideration. Moreover, the momentum of the enormous mass of a coal-tow is so great that the fleets can only be steered by the wheels of the tow-boat by the process technically known as "flanking," in which the action of the wheel is combined with that of the current to move the tow as may be desired.

Coal-fleets vary greatly in size with the stage of water in the river. On 7 feet at Pittsburgh, which is the least that is used, (unless a coal famine below makes it profitable to run out small loads on flats,) tow-boats generally take from seven to ten coal-barges. On 11 feet they take from sixteen to eighteen coal-barges, or ten coal-boats, containing from 200,000 to 250,000 bushels of coal. These are about as large fleets as can be handled in the river above Louisville. Coal-tows destined for points below Louisville are broken up at the falls, and are remade at New Albany into larger fleets, averaging twice the size. The Ajax has taken to New Orleans, in one trip, 539,000 bushels of coal, contained in thirty-two boats and barges, and the Boaz 435,000 bushels, in twenty-seven boats and barges.

The dimensions of some of the principal tow-boats are as follows:

	Ajax.	John A. Wood.	Boaz.	Alps.	J. S. McDonald.	Jos. H. Bigley.	Simpson Horner.	Grand Lake.
	Feet.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Length over all	261	226	212	212	210	208½	226	199
Width over all	48	48	42	40	43	42½	40	39
Height of pilot-houses	40½	45	46	40	43¾	44	40	40
Height of chimneys	71	67	68	67	66	65	65	62

By examining the table it will be seen that during ninety-nine days in each year when the stage of the water is most favorable, the Boaz cannot get her pilot-house under the bridge, and that the same condition holds for the John A. Wood during ninety days.

The McDonald would be stopped during eighty-two days in the year, the Ajax during sixty-two days, and the Grand Lake during fifty-eight days. These boats are among the largest engaged in towing; but there are in all, belonging to the port of Pittsburgh, thirty-six tow-boats of about the same dimensions, and seventy somewhat smaller.

It should also be borne in mind that at the very time when these boats would be stopped they are arriving in the greatest numbers, because it is only at such stages that coal-tows can get over the falls of the Ohio without being subjected to the delay and expense of breaking up. In order to pass through the canal in the spring, when the river is high throughout, coal-boats generally leave Pittsburgh drawing 7 feet of water. They must, therefore, have at least 8 feet in order to go over the falls.

The official records show that when there are 7 feet in the Indiana Chute over the falls, there are 26¼ feet in the channel at Cincinnati, and that when there are 12 feet in the chute the depth at Cincinnati is 36; the ratio for the lower stages of the river being as 1 to 3. As the river rises this ratio changes, 16 feet on the falls corresponding to 43 at Cincinnati. Above 18 feet this disparity disappears, and the river-depths at the two points increase equally. These facts show that at the very time that an unobstructed channel is most needed it is most obstructed by this bridge.

Suppose one of these boats, the Wood, for example, arrives at the Newport bridge with a fleet of eighteen barges, which is not uncommon in the spring, when the river is high throughout, if the river is more than 25 feet above low water she cannot get under the bridge, but must stop and take her tow through piecemeal. Her width, with one barge, is 72 feet; with two it is 96 feet. As the draw-opening is but 100 feet, it would be manifestly dangerous, on account both of the river-current and the cross-current from the pivot-guard, to attempt to take through more than one barge; nor can she take this through without rounding to and dropping through by lines. To get her whole tow through she would have to pass the draw thirty-five times. If she stopped her tow a mile above the bridge, and remade it a mile below, the mere travel would be seventy miles, a distance which might be indefinitely increased should many tows arrive about the same time and occupy the landings. Add to this the loss of time and the multiplication of danger, for no draw has yet been constructed that, in spite of all precautions, has not caused loss of property, and sometimes of life, even to those most accustomed to it, and it is evident to the most unobserving that this arrangement cannot but be prejudicial to navigation. Rates of insurance, which are ultimately paid by the consumer, must inevitably be increased.

The mere passage of a single tow is not the only consideration, for, as a general rule, when coal-fleets come at all they come in large numbers. After the low water of summer the pools of the Monongahela are filled with fleets, all made up, waiting for a rise, and when it comes they all start with a rush, leaving just room enough between fleets to save themselves in case of accident to the fleet in advance. During the recent rise forty-six fleets, of three hundred and sixty-nine barges, containing 4,156,000 bushels of coal, left Pittsburgh within three days. To pass all these, one at a time, through a narrow draw, which, according to the law, "shall not be required to be opened when engines or trains are passing over said bridge, or when passenger trains are due," would take several weeks. At this present time seventy-four trains daily pass over the railroad between Pittsburgh and Rochester, Pennsylvania, and it will not be unreasonable to assume that in a very few years, when Cincinnati's southern connections are completed, at least this number will cross the Newport and Cincinnati bridge. A very simple calculation will show that when this number, or even less, is reached, the delays in passing coal tows will become intolerable.

The only remedy would be to keep low tugs employed to take barges under the bridge while the boat passes through the draw. But this would not obviate the necessity of breaking the tow, as no small tug-boat could control an entire fleet. No matter what means be adopted to remedy the trouble, a great and unnecessary cost would be imposed on the commerce of the country, which would endure forever, for it should be borne in mind that these massive iron bridges are built for all time.

We have not only to protect the present interests of commerce, and all consumers of coal in Cincinnati and below, both private individuals and manufacturing companies, but the interests of the unborn millions who will, in the future, fill up the mighty valleys of the Mississippi and of the Lower Ohio. If this bridge be once allowed to proceed to completion, experience in similar cases shows that it will be almost impossible to change or remove it in the future.

The Cincinnati Commercial, in December, 1868, gave a full description of the first designs for this bridge, stating positively that it was to be 100 feet above low water, with one span of 400 feet, one of 240, and the others of 200. It was to have been a through-bridge, of a width of 41 or 42 feet, and with a railroad-track in the middle, and on each side a wagon-road and foot-path. This statement, which was copied into the Railroad Record for December, 1868, and January, 1869, page 503, could hardly have been made except on official information. Moreover, it is generally acknowledged that the bridge authorities purchased for their approaches property on Butler street, which would only be needed for a high bridge, and which, under the present plan, is distant from the line of road and useless.

After a while a change took place in the composition of the bridge company, and soon after all their plans were modified and the existing design was prepared. The public were not notified that a bridge was to be built in any respect different from that previously announced, and all information in regard to the details of construction was sedulously concealed. Not the slightest intimation was given of the intention to build a low bridge with a draw, and the pivot-pier was not commenced until all the others were under way and its construction could no longer be delayed. The moment the people became aware of what the bridge company was doing, the newspapers sounded the alarm, and meetings were held in all the Ohio River cities and active measures were taken to endeavor to stop the construction of so unexpected and dangerous an obstruction. To all appeals and remonstrances the bridge company contented themselves with pointing to the letter of the law, which unfortunately permitted a low bridge, utterly ignoring the pledge of the company as first organized, that the bridge should be a high one.

To ascertain the amount of commerce affected by the construction of bridges over the Ohio, circulars were sent to the mayors and boards of trade of all towns on the

Ohio River. Fewer replies have been received than was expected, but enough has been obtained to give a general idea of the vast proportion of the commerce that parties, who can see no other interest worth preserving than that of railroads, habitually represented as dying out. From Pittsburgh the annual shipments of coal, by river, are 50,000,000 bushels, scarcely a bushel of which stops short of Cincinnati, and some of which goes to New Orleans. Fifteen hundred large barges and boats, holding from 12,000 to 22,000 bushels of coal each, are required for transportation, and it is taken to market by one hundred and six tow-boats, mostly built expressly for this purpose. Besides coal, 120,000 tons of other articles, giving employment to fifty steamboats and sixty barges, are annually shipped. The estimated value of the packets, tow-boats, and barges belonging to Pittsburgh alone, is $5,000,000.

The record of the shipments of the port of Pittsburgh for 1869 shows that eight-tenths of the entire amount of coal sent to southern ports is transported between the 1st of December and the 1st of July. This would make 60,000,000 bushels passing Cincinnati during these seven months of high water. During this time there are, on an average eighty-five days when there is 25 feet of water in the channel, which is 40 per cent. of seven months. We may safely assume, therefore, that 40 per cent. of the coal running at this time would have to pass through the draw. It is estimated that the average additional cost, in loss of time and interest, and in additional insurance, will amount to 2 cents per bushel. We therefore find that the annual cost to the coal interest, which will ultimately be collected out of the consumer, is 2 cents per bushel on 24,000,000 bushels, or $480,000. In less than three years this would pay the entire cost of the bridge. The estimate of the amount of coal detained is quite within limits, as the records show that instead of 25 feet 28½ is required at Cincinnati to enable coal-boats to cross the falls in safety, and they naturally time their arrivals so as to secure these depths if possible.

It should be kept in mind that a heavy traffic in other articles, of which exact statistics are not so easily obtained, is likewise taxed, and that for many years past the Ohio River commerce in coal, iron, salt, and other bulky articles has yearly increased at an average rate of 20 per cent., and will probably continue to do so unless wantonly destroyed by such obstacles as the Newport and Cincinnati bridge.

Coal-boat pilots assert that it is very difficult to run the channel-span as at present located, especially during high water, on account of the strong set of the current toward the Kentucky shore after leaving the long bend above. From the water-works, 1,600 feet above the bridge, the main current deflects to the Kentucky shore, and in order to reach the channel-span, which is on the Ohio side, coal-fleets must cross this current and flank into the Ohio shore. The channel-pier on the Kentucky side is directly in the path of coal-tows, and it will be difficult to avoid striking it with large and heavy fleets. Had the coal interest been consulted, as it should have been, the 220-foot span, which the law requires to be next to the channel-span, would have been put on the Ohio side of it instead of on the Kentucky side. This would have given ample channel for steamboats in low water, and would have secured for coal-tows, which can only run at a higher stage, the channel which they require and which they have hitherto always used. The bridge company claim to have located their channel-span with the assistance of pilots from Cincinnati. The board were not informed of the names of these pilots and therefore had no chance to examine them, but they feel satisfied that none of them were coal-boat pilots, and that, therefore, they were not the proper persons to have decided the matter.

To change the channel-span now would require the removal of the present Kentucky channel-pier, and its reconstruction at a distance of 220 feet from the present Ohio channel-pier. This would make the new pier the Ohio channel-pier, and would make one of the rest-piers of the draw the Kentucky channel-pier. But this rest-pier, as now constructed, is so light that the board do not think it could with safety be used as a channel-pier, after being raised 30 feet, and therefore they do not recommend a change.

The board are unanimous in their opinion that the bridge as now being constructed is so serious an obstruction to navigation as to call for the interference of Congress, as provided for in the act authorizing its construction, and they would recommend that that portion of the law of July 14, 1862, which authorizes the construction of low draw-bridges over the Ohio River be repealed.

But the law as it stands has been violated by the bridge company, in not complying with the requirement that "the piers of said bridge shall be parallel to the current of the river as near as practicable." There was no attempt made to do this except in locating the position of the pivot-guard above the pivot-pier, which location shows that the same thing was practicable for all the other piers, and it is, in fact, a virtual acknowledgment of the point by the bridge company. The piers of the bridge make an angle with the current of about 12°, which, besides having the effect of presenting a deceptive appearance to the navigator approaching the bridge, practically shortens the 400-foot span to 390 feet, which is 10 feet less than the law requires.

The apparent reason for so locating the piers was to lessen the curvature of the approach on the Cincinnati side from the depot of the Little Miami Railroad, and for so slight a reason even the inadequate provisions of a law that was never expected to be applied to such site were lessened.

If this bridge be allowed to stand as it is it will be difficult to prevent other equally injurious bridges from crossing the Ohio at all points from Pittsburgh to Cairo, until the river traffic is absolutely ruined. No nation can afford to destroy a natural channel of communication for an artificial one. The governments of Europe guard their water-courses with the most jealous care, and, while their railroads cross and recross them wherever necessary, their bridges are so arranged as not to sacrifice either interest. They add new channels while retaining all that nature gave. Their bridges are all built under the watchful care of the engineers of the government, who not only see that their plans are correct in the first place, but who watch every detail of construction to see that the work is carried on in good faith. A general law compelling such a course in this country, wherever a navigable river is bridged, is yearly becoming more imperative.

PROPOSED MODIFICATIONS AND ALTERATIONS OF THE NEWPORT AND CINCINNATI BRIDGE AND ADDITIONAL COST OF THE SAME.

We unhesitatingly recommend the following modifications of this bridge:

First. That the channel-span be raised 28½ feet, so that there shall be a clear headway at low water of 100 feet below the floor-beams suspended from the bottoms of the posts.

Second. That the pivot-pier and all its appurtenances be removed from the river, and a single span be placed to cover the present draw-openings.

Third. That the remaining portion of the bridge be raised sufficiently to allow the railroad to pass over the top chord of its trusses; and that the wagon-road on either side ascend to the height of the channel span, along the sides of the trusses, at grades not to exceed those at present adopted.

Fourth. That the wagon and railroad approaches be raised sufficient to suit this elevated channel span.

We present herewith an estimate of the cost of making these changes:

Estimate of additional cost of raising piers in the river so as to make the channel-span 100 feet above low water.

Pier No. 1, raised 20 feet, 100 cubic yards masonry, at $20	$2,000
Pier No. 2, raised 20 feet, 100 cubic yards masonry, at $20	2,000
Pier No. 3, raised 29 feet, 212 cubic yards masonry, at $20	4,240
Pier No. 4, raised 29 feet, 212 cubic yards masonry, at $20	4,240
Pier No. 5, raised 3 feet, 32 cubic yards masonry, at $20	640
Pier No. 6, removed; material will pay for work	....
Pier No. 7, raised 3 feet, 32 cubic yards masonry, at $20	640
Pier No. 8, raised 3 feet, 22 cubic yards masonry, at $20	640
Pier No. 9, not raised	....
	14,400

Estimate of additional cost on Newport side of approaches for railroad, with bridge raised to 100 feet above low water.

To raise Front street abutment 28 feet, 100 cubic yards masonry, at $18	$1,800
For five iron trestles between Front and Market streets	5,000
To alter and raise 28 feet the abutments for railroad bridge across Market street, 120 cubic yards masonry, at $18	2,160
For six iron trestles between Market and Taylor streets	5,400
For two abutments at Taylor street, 170 cubic yards masonry, at $18	3,060
For bridge over Taylor street, 70-foot span	3,200
For fourteen iron trestles between Taylor and Bellevue streets	15,000
For abutments to bridge over Bellevue street, 120 cubic yards masonry, at $18	2,160
For bridge over Bellevue street, 70-foot span	3,200
For six iron trestles between Bellevue and Madison streets	6,000
For abutments for bridge over Madison street, 160 cubic yards masonry, at $18	2,880
For bridge over Madison street 70-foot span	3,200
For ten iron trestles between Madison and Jefferson streets	9,000
For abutments for railroad bridge over Jefferson street, 115 cubic yards masonry, at $18	2,070
For approach from crossing of Jefferson street, down to grade of Saratoga, similar to that now built between Market and Southgate streets	8,000
	72,130

Approaches on Cincinnati side.

To raise the wagon-way 21 feet on eight brick arches between present main abutment and Front street:

1,450 cubic yards additional brick-work, at $15	$21,750
900 cubic yards additional stone masonry, at $15	13,500
850 cubic yards additional concrete, at $6	5,100
75 cubic yards additional coping stone, at $25	1,875
For two bridges for wagon-road across Front street, each 10 feet wide, and 80-foot span	5,000
For abutments for wagon-bridge over Front street, 333 cubic yards masonry, at $18	5,994
Embankment on wagon-approach from city grade to crossing of Front street, 434 cubic yards masonry, at $15	6,510
1,000 cubic yards earth filling, at 50 cents	500
145 cubic yards Macadam stone, at $2	290
Iron railway	1,000

To raise railway approaches on Cincinnati side:

One railroad span of 96 feet over present brick arches	6,000
Masonry for piers of above span, 103 cubic yards, at $18	1,854
Masonry for piers of span across Front street, 244 cubic yards, at $18	4,392
15 iron trestles, 30 feet apart, including foundations and connecting beams, (average 45 feet in length,) at $1,500	22,500
Masonry of two piers for span of bridge across Eggleston avenue, 1,140 cubic yards, at $18	20,520
Railroad span of 97 feet	6,000
13 iron trestles, in a distance of 410 feet, height from 27 to 37 feet	15,600
Two piers for railroad span across Kilgore street, 185 cubic yards masonry, at $18	3,330
Railroad span of 45 feet across Kilgore street	1,500
33 iron trestles, 30 feet apart, decreasing in height from 30 feet to 15 feet in a distance of 990 feet	24,750
Piers for bridge at intersection of Pearl and Front streets, 150 cubic yards masonry, at $18	2,700
Railroad bridge, 75-foot span, between Pearl and Front streets	3,400
800 feet railway embankment, descending to grade of Front street, retained by masonry walls:	
1,700 cubic yards masonry, at $10	17,000
2,200 cubic yards earth-filling, at 50 cents	1,100
	192,165

Summary.

Cost of raising piers in the river	$14,400
Cost of approaches on Newport side	72,130
Cost of approaches on Cincinnati side	192,165
Cost of raising trusses already erected, and making necessary changes	10,000
Total cost of proposed modifications	288,605

Amount that might have been saved by constructing a high bridge originally.

Pier No. 6 and appurtenances	$94,200
Wooden trestle-work from Front street, Cincinnati, to Little Miami depot	22,400
Part of masonry in railroad approaches	5,400
Cost of raising trusses and alterations of roadway	10,000
	132,000

There are several things about this bridge which demonstrate the necessity of having some one of skill and judgment to represent the United States, and to decide upon the site of every bridge built under its laws over navigable streams, and upon the location of their piers. The position selected for the channel-span is one instance to the point. It is over the main channel at an unimportant stage. The law cannot be specific in such a matter, and no general law could be adequate for all cases. Some discretionary power should be lodged with some one, as each case arises. It would materially aid the bridge companies.

There has been a United States officer in charge of the improvement of the Ohio River all the time the bridge has been building, and his advice and assistance, at any time, could have been obtained, but we cannot learn that they were ever sought.

Cases may frequently arise in which it is impossible to comply with the exact letter of the law; and yet it would not be safe for the interests of navigators to permit bridge companies to decide, upon their own responsibility, what modifications are necessary, and at the same time not injurious to navigators. The provision that the clear channel span shall be 400 feet, and the next one 220, uses up so much of the river space that there is but little margin left for selecting a place for a draw.

In the case now before us, the Newport and Cincinnati Bridge Company seem to have been forced by circumstances to place their draw where it is. The vital difficulty, however, is that no low bridge with any kind of a draw is admissible in this locality.

Appendix E.

WASHINGTON, D. C., *February* 7, 1871.

GENERAL: I have the honor to transmit herewith a report of the board of United States engineers on the Ohio River bridges, giving the condition of their investigations up to this date. The report states the impracticability of their completing the final report upon the details of the bridges already constructed before the 4th of March, and offers a project of a general law in regard to bridging the Ohio River hereafter, with accompanying remarks explanatory of the necessity for the provisions of the law.

Yours, respectfully,

G. K. WARREN,
Major Engineers and Brt. Maj. Gen. U. S. A., President of the Board.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army.

WASHINGTON, D. C., *February* 7, 1871.

GENERAL: The board of engineers appointed to report on Ohio River bridges would respectfully state that, after mature deliberation, they have concluded that they cannot get their report ready in time to be submitted at the present session of Congress. The questions to be considered are so important that they require the most careful investigation.

There are in all eight bridges over the Ohio River, which, by act of Congress, we are required to consider. They are as follows: The Steubenville railroad-bridge, the Wheeling suspension-bridge, the Bellaire railroad-bridge, the Parkersburgh railroad-bridge, the Newport and Cincinnati railroad-bridge, the Covington and Cincinnati suspension-bridge, the Louisville railroad-bridge, and the Paducah bridge. Of these the bridges at Steubenville and Wheeling, and the suspension-bridge at Cincinnati, have been finished for several years; that at Louisville for one year; that at Parkersburgh has just been finished; the Bellaire bridge will probably be finished early in the summer; the Newport and Cincinnati bridge is half finished, and the Paducah bridge has not been begun. It is manifest that no delay in the consideration of a bridge that is already completed can affect injuriously the existing status. The only bridges, therefore, that require speedy consideration are those that are in process of construction. We have already reported at length on the Newport and Cincinnati bridge, giving at the same time a general description of all the others, and the report has been transmitted to Congress, and has been printed. The modifications which, in the judgment of the board, should be made in this bridge have been clearly indicated. They cannot, in any way, be affected by the condition of affairs at any other bridge.

At Bellaire the piers in the river are all finished, and one span of the superstructure is in place. The bridge is being built according to law, and it is believed that no changes will be required. The other unfinished bridge is that at Paducah, toward which nothing has yet been done, except to secure a charter from Congress.

Our surveys have all been made, and the maps are nearly completed, but the report cannot be finished before the 4th of March next. Under these circumstances we have thought it best to take ample time for the consideration of the other bridges.

As our examinations and surveys have already given us sufficient information to enable us to recommend the necessary legislation for future bridges, which is a matter that need not in any way be complicated with the question of the bridges already built, we have concluded to submit the following project of a law in regard to bridges over the Ohio River, which we believe to be reasonable and just, and to require no more of bridge companies than is absolutely essential for the preservation of the rights of navigation.

A BILL to authorize the construction of bridges across the Ohio River.

Be it enacted, &c., That every bridge hereafter erected across the Ohio River, above the mouth of the Big Sandy, shall have at least one span of a height of not less than 90 feet above low water, and of not less than 10 feet above local highest water, measured to the lowest part of the span; that every bridge hereafter erected across the Ohio River below the mouth of the Big Sandy shall have at least one span of a height of not less than 100 feet above low water, and of not less than 40 feet above highest water, measured to the lowest part of the span; that this high span shall give a clear opening of at least 400 feet between the piers, measured at right angles to the current at every stage, and that it shall be placed over that portion of the river used by boats during ordinary stages of water: *Provided,* That in case this high span is not over the low-water channel, suitable arrangements be made elsewhere to permit the passage of single boats under the bridge at low water; that all bridges over the Ohio River below the Covington and Cincinnati suspension-bridge shall have, in addition to the high span prescribed above, a pivot-draw, giving two clear openings of 160 feet each, measured at right angles to the current at the average stage of water in the river, and located in a part of the bridge that can be safely and conveniently reached at that stage: and that said draw shall be opened promptly, upon reasonable signal, for the passage of boats whose construction shall not be such as to admit of their passage under the permanent spans of said bridge, except when trains are passing over the same.

SEC. 2. *And be it further enacted,* That the piers of the high span and the piers of the draw shall be built parallel with the current at that stage of the river which is most important for navigation; and that no ripraps or other outside protection for imperfect foundations will be permitted in the channel-way of the high span, or of the draw openings.

SEC. 3. *And be it further enacted,* That any person, company, or corporation authorized to construct a bridge across the Ohio River by the States upon whose territory said bridge will abut, shall submit to the Secretary of War, for his examination, a design of the bridge and piers, and a map of the location, giving, for the space of at least one mile above and one mile below the proposed location, the topography of the banks of the river, the shore-lines at high and low water, the direction of the current at all stages, and the soundings accurately showing the bed of the stream, and shall furnish such other information as may be required for a full and satisfactory understanding of the subject by the Secretary of War; and if the Secretary of War is satisfied that the provisions of the law have been complied with in regard to location, the building of the piers may be at once commenced; but if it shall appear that the conditions prescribed by this act cannot be complied with at the location where it is desired to construct the bridge, the Secretary of War shall detail a board, composed of three experienced officers of the Corps of Engineers, to examine the case, and may, on their recommendation, authorize such modifications in the requirements of this act as will permit the construction of the bridge: *Provided,* That the free navigation of the river be not materially injured thereby.

SEC. 4. *And be it further enacted,* That all parties owning or operating bridges over the Ohio River shall maintain, at their own expense, from sunset to sunrise throughout the year, such lights on their bridges as may be required by the Light-House Board for the security of navigation.

SEC. 5. *And be it further enacted,* That any bridge constructed under this act, and according to its limitations, shall be a lawful structure, and shall be recognized and known as a post-route, upon which, also, no higher charge shall be made for the transmission over the same of the mails, the troops, and the munitions of war of the United States, than the rate per mile paid for the transportation over the railroads or public highways leading to said bridge; and in case of any litigation arising from any obstruction or alleged obstruction to the navigation of said river created by the construction of any bridge under this act, the cause or question arising may be tried before the district court of the United States of any State in which any portion of said obstruction or bridge touches.

SEC. 6. *And be it further enacted,* That the right to alter or amend this act so as to prevent or remove all material obstructions to the navigation of said river by the construction of bridges is hereby expressly reserved.

SEC. 7. *And be it further enacted,* That joint resolution No. 10, approved April 7, 1869, authorizing the construction of a bridge over the Ohio River, at Paducah, be, and the same hereby is, repealed.

EXPLANATORY REMARKS.

In draughting the above bill the board had before them Senate bill No. 622, second session Fortieth Congress, which was discussed in the Senate, but not passed, a substitute having been adopted directing the appointment of a board of engineers.

The following remarks are annexed, in order to explain the reasons for some of the requirements in the bill which we recommend, and also the changes from Senate bill No. 622.

Section 1. This section has been greatly modified. Measurements of height are now to be made to "the lowest part of the span" instead of to the bottom chord, because bridge-builders sometimes suspend floor-beams, or other members, below the bottom chord. Different heights above low water have been prescribed for bridges above and below the mouth of the Big Sandy. The reasons for this are: 1st. There are already four bridges built above the Big Sandy with a height of 90 feet above low water, while those already built below this river have a height of 100 feet, excepting the Ohio Falls bridge, which has an exceptional location, and the Newport and Cincinnati bridge, 71½ feet above low water, which we have recommended to be raised to 100 feet above. 2d. The greater rise and fall of the river below the mouth of the Big Sandy, and the greater duration of high stages, make higher bridges necessary to secure the same accommodation to river commerce. 3d. The natural features of the mountain regions of Virginia and Kentucky are such as to compel all east and west railroads to cross the Ohio above the mouth of the Big Sandy, while the roads crossing below will be those seeking southern connections, and the roads of each class will be on a par with each other as to heights of bridges. We have placed the widest opening in that part of the river ordinarily used by coal-fleets, for whose accommodation these wide openings were designed, and have introduced a provision for the benefit of packet steamers, that run when the river is too low for coal-tows, by requiring a high span over the low-water channel also, if it be not covered by the longest span. This only requires that this span be what is called a "through" or "overgrade" bridge, with the track on the bottom chord; but it is not necessary to specify any particular length of span, as economy in constructing the piers will naturally lead bridge companies to adopt for all their spans over the river proper such dimensions as will easily accommodate single steamers.

In the present state of commerce on the Ohio River the largest river steamers very seldom ascend above Cincinnati, and the bridges already constructed have made it impossible for them to do so without lowering their chimneys. Boats that habitually run on the Upper Ohio are fitted with the necessary contrivances for this purpose, but those that usually ply between St. Louis and New Orleans, between which ports there are no bridges, have no such facilities, and are very loath to obtain them. Many of these boats have chimneys 5½ feet in diameter, extending 50 feet above the hurricane-deck, and it is both difficult and dangerous to lower them. These boats often make extra trips to Cincinnati during high water, when advantageous freights are offered, and if arrangements are not made that will continue to permit this, the commerce of that city, and of Louisville, will be injuriously affected. At present the only bridge between the Covington and Cincinnati suspension-bridge and New Orleans is that at Louisville. This bridge, however, besides being a high bridge, has a draw that answers both for the canal and for the river when it is high, and therefore is no obstacle. Our object is to secure the same admirable provisions for navigation at all other bridges in this section of the river. Another important consideration affecting the question of draws in high bridges is the necessity of some provision in time of war for the speedy transportation of large bodies of troops by steamboats gathered from all sources. Many of the boats so collected would be unable to pass under bridges in high, or even in ordinary water, and serious disasters might result therefrom. The great advantages to be reaped from speedy concentration of troops are so forcibly demonstrated by the course of the present war in Europe as to make this question one that we ourselves cannot safely neglect.

Section 2. This section does not differ materially from the same section in Senate bill No. 622. It allows more latitude in the choice of a site for a bridge, thus making more important the provisions of section 3, which follows.

Section 3. This is the same as the corresponding one in the former bill, except that it gives more authority to the Secretary of War, permitting him to sanction departures from the exact text of the law in cases where a strict construction would needlessly embarrass bridge companies, and where such departures would not injure navigation. It places the whole subject under the control of a cabinet officer, whose position guarantees a due regard to the rights of both river and rail. This control has already been given to the Secretary of War in the case of the International Bridge Company at Buffalo, and it has resulted in a considerable pecuniary saving to them, as well as in a decided gain to navigation. The board of engineers have recommended that the draw of this bridge be placed near the shore, instead of in the middle of the river, thus removing it from a current of six miles an hour to one of four miles, and still maintaining the necessary depth for navigation. The bridge company are also the gainers by the change in that part of their bridge that crosses Black Rock Harbor.

(Section 4, of Senate bill No. 622, has been omitted as unnecessary.)

Section 4. This section provides for the proper lighting of channel-ways of bridges. As a matter of fact, all bridge companies on the Ohio River do light their channel spans; but it was thought best to incorporate this duty in a general law, lest it should at any time be neglected.

Section 5. Copied without change from Senate bill No. 622.

Section 6. Copied without change from Senate bill No. 622.

Section 7. This section repeals the joint resolution authorizing the construction of a bridge across the Ohio at Paducah. This joint resolution is identical with that under which the obnoxious Newport and Cincinnati bridge is being built, and unless repealed at once, before work is begun, may result in the creation at Paducah of a similar obstruction. The effect of repealing this joint resolution will not be to prevent the construction of a bridge at this place, but only to compel it to conform to the law which we have herewith presented.

The general effect of the proposed law is to authorize the construction of bridges at any points on the Ohio River for which a bridge company can get charters from the two States owning the shores.

Respectfully submitted.

G. K. WARREN,
Major Engineers and Brevet Major General, United States Army.
G. WEITZEL,
Major of Engineers and Brevet Major General.
WM. E. MERRILL,
Major Engineers and Brevet Colonel.

General A. A. HUMPHREYS,
Chief of Engineers, United States Army.

APPENDIX L 1.

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, July 31, 1871.

GENERAL: I have the honor to transmit the following report of the operations at the improvement of the falls of the Ohio River and Louisville Canal, for the fiscal year ending June 30, 1871.

On the 21st of July, 1870, I received the official notice that $250,000 had been appropriated for this work, by the act approved July 11, 1870. I accordingly awarded the contracts for widening the prism of the Louisville and Portland Canal to the lowest bidders, at the letting on the 27th of May, 1870, referred to in my last annual report.

A few days after this work of widening the prism of the canal was begun, it was found that in rear of the old side-walls which we removed there was a large mass of loose rock, covered with a few feet of earth and cemented together with earth. We had no reason to expect anything else in rear of these walls but clear earth, either from the appearance or from any information which we had received from those who have been employed on this canal during many years. After we made this discovery, several of these persons did remember that this mass of rock was derived from previous attempts at enlarging the canal, and was thrown in behind the side-walls and covered with earth to save the expense of lifting it on the high banks which border the canal.

This circumstance, together with frequent strikes on part of the workmen, delayed the progress of the work very much, and this delay, together with the lateness of the date on which the appropriation was made, made it possible for only section No. 1 to be completed last season. The contractors on sections Nos. 2, 3, and 4 did considerable work, but still have a large amount to do, and by your authority have been granted an extension until the end of the present season.

In the mean time, the contractors for the enlargement of the entrance to the canal, and those for the completion of the new locks, referred to in my last annual report, prosecuted their respective works with vigor, but did not complete them. But, as no practical benefit would have resulted, even if they had completed their contracts, and as the difficulties which they encountered were greater than were anticipated, their time was also extended by your authority to the end of the present season. Both of these firms have pushed their work with vigor during the last few months, and their work is nearly completed.

The contractor for removing the ledge of rocks inside of the apron-dam, referred to in my last annual report, made several unsuccessful attempts to start his work. In the mean time, I found that the work of the two firms just mentioned would cost more than I had set aside for it, and as that was more important than the latter, I received authority from you to abrogate this contract. This I did upon the contractor giving me a waiver of rights.

The contractors for the dam across the river at the head of the canal did not prosecute their work during last season, and as I ascertained that the same two works above referred to would need the whole amount still available from the allotments under which all of these contracts were made, their contract was concluded under the law, and I paid them their retained percentage.

On the 21st of January, 1871, I received information that an additional appropriation of $200,000 had been made for this work, as requested by me in my last annual report, to enable me to enter into contract for new side-walls on those portions of the canal at which the old side-walls were removed in the work of widening it. But, as the work of excavation incident to this widening progressed, and after I had written my last annual report, I found that the slopes which these new side-walls must sustain were, along the greater part of their length, very wet from springs and from the filtration of the drainage-water from the city of Louisville, which accumulates in the low ground just in rear of the banks which border the canal. In consequence of this it would have been unsafe to build such a wall as I first designed, and I therefore determined upon an enlarged section and heavier stone for this wall. Its expense is increased thereby about $100,000. I therefore advertised for bids to construct the wall according to the new plan, to be carried up to a uniform height, about four feet and three inches below its ultimate height. The bids for this work were opened on the 28th of February, 1871. There were six bidders, as per Abstract A, herewith annexed. The contract was awarded to the lowest bidder, but as he failed to furnish proper security the work was readvertised, and, in order to recover the time lost, was subdivided into five parts. The bids were opened on the 24th of April, 1871. There were six bidders on Part 1, and five each on the other four parts, as per Abstract B, herewith annexed. The contracts were awarded to the lowest bidders, on each part. They all commenced the delivery of material at once, and all had one-half of the material delivered, as required, on the 20th of this month, and the contractors on Part 3 had constructed a small portion of the new wall at the end of the fiscal year.

On the 18th of March, 1871, I received information that $250,000 had been appropriated for this work, to be applied during the present fiscal year. The most important points to which this amount could be applied were the removal of the ledge of rocks just below the new locks; the construction of a wall to face the ragged, rocky bluff just below, and on a line with the inside walls of the new locks; the construction of the dam at the head of Sand Island; the moving of the rubble-wall which protects the canal-bank from the encroachment of the river above and below the railroad-bridge, and completing the excavation of the basin at the junction of the new branch and old canal.

The ledge of rocks, as stated in my previous reports, extends into the river at the foot of the new locks, and must be removed in order to enable boats to enter or leave the locks at the lower end, and also to allow the current of the river to sweep along close to the foot of the locks, and thus prevent the deposit of mud which would otherwise continually form at that point.

The rock bluff referred to is composed of limestone and slate, and is very ragged from rough blasting. Its general face is parallel to the center line of the new locks, and is about 15 feet inside of the face of the inside or southern face of the lock-chamber. It is a few feet higher than the top of the walls of the lower chamber. There would be continual liability to damage to boats in entering or leaving the locks from below, whenever a northerly wind is blowing, if this ledge were not smoothened. The best way to do this is by facing this bluff with a wall whose face is simply pick-hammered, and thus smooth enough to prevent injury to boats lying against it in entering or leaving the locks from below.

The dam from the head of Sand Island to the Indiana shore is in lieu of the one recommended by me in my report on the survey for a ship-canal around the falls of the Ohio, dated February 8, 1868, at the head of Falling-Run Pool just below New Albany, Indiana. The change was approved by you for the reason that the same ends will be accomplished, that it will cost less, and will interfere with no interest in its new position.

The moving of the outer protection-wall of the canal is necessary for the following reasons: There are many days during the high stages of the river when steamboats cannot pass under the two channel-spans of the railroad bridge without lowering their smoke-stacks, and some days when very large boats could not pass under even if the stacks were lowered. This involves much delay, and as it affects the larger class of boats, involves much expense. Now this railroad-bridge spans the canal with a draw which turns on a round pier placed just on the northern face of the canal, and when open gives a clear space between this round pier and the pier of the bridge just north of it. If then the space between these two piers were clear, the largest boat on the river could pass through without lowering its stacks. But the northern bank of the canal, with its rubble protection-wall, takes up about seventy feet of this space. Now, by removing this bank and setting the wall back flush with the northern edge of the round pier on which the draw turns, for a short distance above and below the bridge, we have a clear high-water channel through it. This is one of the most important portions of this work, and its completion is looked forward to by all interested in the navigation of the river, with great delight. My letter of August 29, 1870, with the sketch which accompanied it, will explain this work more fully to you.

The new branch and the basin, in order to expedite matters, were only excavated to a width of ninety feet. There remains the balance of the earth and rock excavation to be completed in order to carry out the original plan.

In order, then, to save time, I advertised for bids for these various points as soon as I could prepare the working-drawings and specifications.

On the 1st of May, 1871, I opened the bids for the earth and rock excavation in the new branch and basin, and for moving the outer protection-wall above and below the railroad-bridge. There were six bidders for the former work and eight for the latter, as per Abstracts C and D, herewith annexed. The contracts in both cases were awarded to the lowest bidders.

On the 17th of May, 1871, I opened the bids for the construction of the dam at the head of Sand Island, and for the rock excavation and construction of the guide-wall at the foot of the new locks. There were nine bidders on the former work and five on the latter, as per Abstracts E and F, herewith annexed. The contracts in both cases were awarded to the lowest bidders.

After these various works were awarded, I found that I would still have available about $50,000, if the quantities did not overrun my estimates. I hoped that this amount would be sufficient to complete the dam at the head of the canal and the excavation of the ledge of rocks inside of the apron-dam, and consequently advertised for bids for this work on the 22d of June, 1871. The result of this advertisement properly belongs to my next annual report.

All of the contractors for the new work have made favorable beginnings, and if all of them, old and new, complete their work, the canal will be passable for any boat not larger than the capacity of the new locks (80 feet by 335 feet) on the 1st of next November, or as soon thereafter as the directors of the canal can dredge out of the new locks the mud which has been deposited in them by back-water during the high stages of the river.

On the 23d of August, 1870, I opened the bids for the construction of the guard-gates at the head of the canal. There were three bidders, as per Abstract G, herewith annexed. The contract was awarded to the lowest bidder, and he completed his work during the season.

There will then remain to be done the following to complete this work according to the original plan, viz:

1. To carry up the side-walls to their full height.
2. To build a retaining-wall from the lower part of the first passing-place in the canal to the head of the canal on the south, or Louisville side, and thus complete the enlargement and improvement of the entrance to the canal. This wall was not placed under contract before, because I had no time to examine into the character of the foundations by boring until last month.
3. To grade the banks of the canal.
4. To complete the dam at the head of the canal and to excavate the ledge of rocks inside of the apron-dam.

These four points will cost $300,000 in addition to the amount yet available, provided the amount is appropriated at one time, and I, therefore, request that this amount be appropriated for this work, to be expended during the fiscal year ending June 30, 1873.

The amounts that have been appropriated for this work up to date are as follows:

Allotted in 1868	$85,000
Allotted in 1869 (1 per cent. off)	178,200
Appropriated in 1870	450,000
Appropriated in 1871	250,000
Total	963,200
Amount still required as above stated	300,000
Total	1,263,200
Amount required according to my original estimate, (see last annual report)	1,243,500
Excess over original estimate	19,700

I am confident that if the money could have been given me under our system of appropriations for public works as I called for it, so that I could have carried on the work in a more business-like manner, it could have been done for at least $100,000 less, even though I was compelled to alter the dimensions of the side wall, and thus create an additional expense of $100,000, not contemplated in my original estimate. A large portion of the amount would have been saved of contingent expenses alone. For this reason I sincerely hope that the whole of the $300,000 yet required to complete this work will be appropriated at once. The work still to be done should be completed as soon as possible. The entrance to the enlarged canal should be proportionally enlarged. Hence the wall on the Louisville side at the head of the canal, and the rock excavation inside of the apron-dam, should be completed. The walls should be carried up to their full height, so as to insure their stability against the great pressure they must bear, and to guard them against damage from the weather which is likely to result in the absence of coping. The banks should be graded immediately, for their slopes were necessarily made very steep to enable the money that was available last year to cover the work of widening the prism. They will consequently bring a much larger pressure to bear on the walls, and will certainly cave in more or less after high stages of the water. The dam should be completed as soon as possible, in order to give the increased depth of water in the canal which it will produce, and to save the rent of the lot on which the lumber is stored and the house in which the iron is stored.

This work is located in the third collection district of Kentucky. The nearest port of entry is Louisville, Kentucky.

The amount of revenue collected at this port of entry during the fiscal year ending June 30, 1871, was $131,810 92.

The commerce and navigation of the Mississippi River and all its branches would be benefited by the completion of this work.

Abstract H (herewith annexed) shows the names of the persons to whom contracts have been awarded.

That portion of this report wherein I have stated what I have done, explains fully the steps I have taken to prosecute the work.

The amount of cash received for this work during the fiscal year ending June 30, 1871, is $353,200. The amount expended during the same period was $258,830 23.

The amount of appropriation available June 30, 1871, was $450,000. The amount required for the fiscal year ending June 30, 1873, is $300,000.

I do not propose to make any further alterations in the plans heretofore reported.

I consider it my duty to reproduce here the following extract from my last annual report:

> In conclusion, I feel it my duty again to call the attention of the authorities to their duty in relation to this work. Every day forces more and more upon me that the Government is in honor bound immediately to assume charge of this canal. The first set of bonds, amounting to $370,000, which the Louisville and Portland Canal Company issued, in order to enable them to enlarge this canal, and build the branch and new locks, are due next January. The company will pay them off on maturity, with the assets in their hands.
>
> The debt that then will rest upon the canal is as follows, viz:

399 bonds, due in 1876	$399,000 00
398 bonds, due in 1881	398,000 00
400 bonds, due in 1886	400,000 00
	1,197,000 00

These bonds bear a 6 per cent. currency interest.

By assuming these bonds and purchasing the five shares of stock (each at $100) held by the five directors of the company, the Government gets a piece of property worth at least $3,000,000, and by then converting it into a free canal, (that is, charging only toll enough to pay running expenses and repairs,) it will do an act of very tardy justice to at least one-half of its population, all interested in the navigation of this river, and from whom already nearly $5,000 of cash money has been unjustly taken in the way of tolls, to enable them to make use of this national highway.

I will not repeat the facts which many others and I have already stated, to prove that this is the duty of the Government, but will simply refer to the various printed public documents bearing upon the subject, and, as one of the servants of the Government, earnestly invoke its attention to the facts therein stated.

The company paid off the first set of bonds at maturity.

I am, sir, very respectfully, your obedient servent,

G. WEITZEL,

Major of Engineers.

Brigadier General A. A. HUMPHREYS,

Chief of Engineers, U. S. A., Washington, D. C.

A.—*Abstract of bids received by Major G. Weitzel, Corps of Engineers, for work to be done in the construction of the retaining-walls and excavation in canal and branch of the Louisville and Portland Canal. Letting, February 28, 1871.*

Name of bidder.	Earth excavation. 18,800 cubic yards.	Rock excavation. 6,400 cubic yards.	Removing old wall. 4,700 cubic yards.	Masonry on first plan.		Masonry with buttresses.		Total on first plan.		Total with buttresses.	
				17,800 cubic yards.	31,000 cubic yards.	17,800 cubic yards.	31,000 cubic yards.	17,800 cubic yards.	31,000 cubic yards.	17,800 cubic yards.	31,000 cubic yards.
Branham, Cobb & Co.	$0 60	$2 25	$1 25	$12 25	$12 75	$12 00	$12 50	$249, 605 00	$426, 805 00	$245, 155 00	$419, 055 00
Brehm & Wirth	76	2 65	1 75	12 15	11 55	11 70	11 10	255, 743 00	397, 523 00	247, 733 00	383, 573 00
H. McGilincey & Co.	65	2 35	1 35	8 50	9 50	8 25	9 25	184, 905 00	328, 105 00	180 455 00	320, 355 00
Boyle, Roach & Co.	1 50	2 50	75	10 90	12 00	10 92	12 02	241, 745 00	419, 725 00	242, 101 00	420, 345 00
Samuel Black & Co.	53	2 25	1 00	9 85	11 00	10 00	11 20	204, 394 00	370, 064 00	207, 064 00	376, 264 00
Byrne & McKenzie	73	2 15	1 15	10 15	10 25	10 00	10 45	213, 559 00	350, 639 00	210, 889 00	356, 839 00

Respectfully submitted.

G. WEITZEL, *Major of Engineers.*

B.—*Abstract of bids received by Major G. Weitzel, Corps of Engineers, for constructing new retaining-walls and excavations in the Louisville and Portland Canal, &c., and new branch of the same. Letting, April 24, 1871.*

PART 1.

Name of bidder.	Rock excavation in canal and branch, 1,500 cubic yards.	Earth excavation for foundation, 2,500 cubic yards.	Removing old wall, 300 cubic yards.	Masonry, 3,300 cubic yards.	Total.
Branham, Cobb & Co	$2 25	$0 63	$1 00	$11 75	$44, 025 00
Michael Gleason	2 10	50	1 15	12 50	45, 995 00
Pollack & Leopold	2 50	60	1 40	12 00	45, 270 00
J. C. Dennis	1 90	45	1 25	10 40	38, 670 00
Byrne & McKenzie	2 25	55	1 20	9 75	37, 285 00
Conner & Rogers	2 20	80	1 00	9 85	38, 105 00

PART 2.

Name of bidder.	Earth excavation for foundation, 3,900 cubic yds.	Masonry, 1,400 cubic yards.	Total.
Branham, Cobb & Co	$0 65	$11 75	$18, 985 00
Boyle & Roach	99	11 00	19, 261 00
J. C. Dennis	50	10 50	16, 650 00
L. B. Redd & Brother	60	11 50	18, 440 00
Conner & Rogers	80	12 00	19, 920 00

PART 3.

Name of bidder.	Earth excavation in canal and branch, 7,900 cubic yards.	Rock excavation in canal and branch, 2,100 cubic yards.	Masonry, 4,800 cubic yards.	Total.
Branham, Cobb & Co	$0 70	$2 40	$12 25	$69, 370 00
Boyle & Roach	84	2 14	9 89	58, 602 00
Samuel Black & Co	65	2 35	12 00	67, 670 00
L. B. Redd & Brother	60	2 20	11 50	64, 560 00
Conner & Rogers	80	2 20	11 25	64, 940 00

PART 4.

Name of bidder.	Earth excavation for foundation, 2,000 cubic yards.	Rock excavation for foundation, 1,700 cubic yards.	Removing old wall, 2,300 cubic yards.	Masonry, 4,000 cubic yards.	Total.
Branham, Cobb & Co	$0 60	$2 25	$1 00	$11 75	$54, 325 00
Boyle & Roach	79	1 90	48	8 74	40, 874 00
Samuel Black & Co	75	2 35	1 25	12 20	57, 170 00
Byrne & McKenzie	73	2 20	1 35	12 10	56, 705 00
Conner & Rogers	80	2 20	1 00	10 35	49, 040 00

PART 5.

Name of bidder.	Earth excavation for foundation, 2,500 cubic yards.	Rock excavation for foundation, 1,100 cubic yards.	Removing old wall, 2,100 cubic yards.	Masonry, 4,300 cubic yards.	Total.
Branham, Cobb & Co	$0 60	$2 25	$1 00	$11 75	$56, 603 00
Boyle & Roach	92	1 90	50	9 18	44, 914 00
Samuel Black & Co	75	2 35	1 25	12 20	59, 545 00
Byrne & McKenzie	73	2 20	1 25	12 10	58, 900 00
Conner & Rogers	80	2 20	1 00	10 35	51, 025 00

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for certain earth and rock excavation in the new branch of the Louisville and Portland Canal. Letting, May 1, 1871.

Name of bidder.	Earth excavation, 17,000 cubic yards.	Rock excavation, 4,500 cubic yards.	Removing old pavement, 900 cubic yds.	Total.
M. J. O'Conner	$0 60	$1 80	$0 60	$18, 840
Boyle & Roach	90	1 87	90	24, 525
H. T. Cook & Co	57	2 65	65	22, 200
Samuel Black & Co	55	2 10	60	19, 340
Michael Gleason	55	1 75	40	17, 585
D. Mathison & Co	75	2 70	80	25, 620

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for moving the outer protection-wall of the Louisville and Portland Canal, at and above the railroad bridge. Letting, May 1, 1871.

Name of bidder.	Masonry, 4,000 cubic yards.	Earth excavation, 30,000 cubic yards.	Total.
D. Mathison & Co	$5 95	$0 35	$34, 300 00
J. C. Dennis	5 00	70	41, 000 00
Samuel Black & Co	10 00	50	55, 000 00
H. T. Cook & Co	7 50	58	47, 400 00
Boyle & Roach	9 00	75	58, 500 00
Marshall S. Lord	4 95	39½	31, 650 00
Byrne & McKenzie	5 98	43	36, 820 00
M. J. O'Conner	6 00	45	37, 500 00

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for the construction of a masonry and riprap low-water dam from the head of Sand Island to the Indiana shore. Letting, May 17, 1871.

Name of bidder.	Earth excavation, 1,000 cubic yards.	Masonry, 1,650 cubic yards.	Riprap, 5,100 cubic yards.	Total.
Byrne & McKenzie	$0 98	$15 00	$3 94	$45, 824 00
M. J. O'Conner	55	14 00	5 00	49, 150 00
Boyle & Roach	90	9 00	4 25	37, 425 00
J. C. Dennis	50	15 00	7 00	60, 950 00
J. H. Maddox	60	14 00	8 00	64, 500 00
Samuel Black & Co	50	8 50	5 00	40, 025 00
Myers & Kerr	94	9 44	2 94	31, 510 00
D. Mathison & Co	75	12 50	6 25	53, 250 00
Ferrell & Clark	50	9 50	3 00	31, 475 00

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for the construction of the guide-wall and rock excavation just below the new locks of the Louisville and Portland Canal. Letting, May 17, 1871.

Name of bidder.	Earth excavation, 29,000 cubic yards.	Rock excavation, 12,900 cubic yards.	Masonry, 3,400 cubic yards.	Stone filling, 1,600 yards.	Total.
M. J. O'Conner	$0 60	$3 10	$14 05	$2 00	$108, 360 00
Boyle & Roach	90	2 95	8 00	1 50	93, 755 00
H. T. Cook & Co	75	2 50	12 00	2 00	98, 000 00
Samuel Black & Co	87	4 50	12 00	1 00	125, 680 00
J. C. Dennis	70	2 75	14 00	1 50	105, 775 00

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for work to be done and material to be delivered in constructing the upper guard-gates in the Louisville and Portland Canal. Letting, August 23, 1870.

Name of bidder.	Pine lumber and timber, 37,900 ft. b. m.	Oak lumber and timber, 4,120 ft. b. m.	Cast-iron work, 34,000 pounds.	Wrought-iron work, 13,000 pounds.	All the labor necessary to put the gates in complete working order.	Total.
C. and G. Cook & Co	$70 00	$60 00	$0 07½	$0 10½	$2, 785 00	$9, 600 90
Roderick McKenzie	63 00	40 00	8	10½	3, 700 00	10, 337 50
Jacob B. Thompson	70 00	70 00	12	14	5, 950 00	14, 791 40

A.—*Abstract of the names of persons to whom contracts have been awarded.*

Name.	Residence.	Nature of work.
Byrne & McKenzie	Louisville, Ky	Constructing the new retaining-walls in Part 1 of the Louisville and Portland Canal.
J. C. Dennis	do	Constructing the new retaining-walls in Part 2 of the Louisville and Portland Canal.
Boyle & Roach	Cincinnati, Ohio	Constructing the new retaining-walls in Parts 3, 4, and 5 of the Louisville and Portland Canal.
Michael Gleason	New Albany, Ind	Excavating certain earth and rock in the new branch of the Louisville and Portland Canal.
Marshall S. Lord	Louisville, Ky	Moving the outer protection-wall of the Louisville and Portland Canal at and above the railroad bridge.
Ferrell & Clark	do	Constructing a masonry and riprap low-water dam from the head of Sand Island to the Indiana shore.
Boyle & Roach	Cincinnati, Ohio	Constructing the guide-wall and rock excavation just below the new locks of the Louisville and Portland Canal.
C. and G. Cook & Co	New Albany, Ind	Constructing the upper guard-gates in the Louisville and Portland Canal.

UNITED STATES ENGINEERS OFFICE,
Louisville, Kentucky, July 31, 1871.

GENERAL: I have the honor to submit the following report of the operations at the improvement of the Cumberland River, below Nashville, Tennessee, for the fiscal year ending June 30, 1871.

On the 18th of March, 1871, I received information that $30,000 had been appropriated for the improvement of this river. This amount was not sufficient to remove either of three formidable obstructions on this river below Nashville, which are:

1. Harpeth Shoals. This includes the collection of rocky ledges and gravel bars severally known as Flax, Patch, Harpeth Island, Sycamore Creek, and Harpeth River Bar, and Reed's Reef.
2. Ingram Shoals.
3. Dover Island Shoals.

I therefore concluded to expend the amount (less 10 per cent. reserved for contingent expenses) in removing the different obstructions, beginning at Nashville and going down. This method would bring us soonest to the Harpeth Shoals, which are the most formidable obstructions. Between them and Nashville there are but three small points to improve, and these I concluded to place under contract at the same time, so as to have the river improved as far as the money would permit me to go.

On the 17th of June, 1871, I opened the bids for the work. I received only two bids, as per abstract A, herewith annexed. I awarded the work to the lowest bidder. He has commenced his preparations for work, and if the stage of the water in the river remains favorable, I think that he will complete his work during the present season. His contract embraces the removal of the old foundation at Nashville, the obstructions at Nashville and Gower's Island and at the Harpeth Shoals, as far as $27,000 will carry the work.

The total amount required for the completion of this work, according to the data we now have on hand, as reported in my special report on the survey of the Cumberland River, dated January 20, 1871, is	$248, 821 00
Appropriated by act of March 3, 1871	30, 000 00
Total still to be appropriated	218, 821 00

This whole amount, which would be sufficient to improve the river from Nashville to its mouth, should be appropriated, and could be profitably expended during the next fiscal year. But if this cannot be done, at least $80,000 should be appropriated to remove the obstructions at Harpeth Shoals.

The river flows through several collection districts, the names of which are not known to me.

The nearest port of entry is Louisville, Kentucky. The amount of revenue collected at this port during the fiscal year ending June 30, 1871, was $131,810 92.

The commerce and navigation of the Mississippi River and all of its branches would be benefited by the completion of this work.

No money was received and none expended on this work during the fiscal year ending June 30, 1871.

The amount of the appropriation available July 1, 1871, was $30,000.

The amount required for the fiscal year ending June 30, 1873, and which can be profitably expended, is $218,821.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Abstract of bids received by Major G. Weitzel, Corps of Engineers, for the improvement of the Cumberland River, at the city of Nashville, Nashville Island, Gower's Island, and Harpeth Shoals. Letting, June 17, 1871.

Name of bidder.	Removing pier at Nashville.	Blasting in channel at Nashville.	Removing wreck at Gower's Island.	Dredging sand at Gower's Island, 400 cubic yards.	Dredging sand at Harpeth Dam, 1,400 cubic yards.	Riprap dam, 10,500 cubic yards.	Rock excavation at Harpeth Island, 300 cubic yards.	Total.
J. H. Maddox	$300 00	$50 00	$300 00	$0 75	$0 75	$1 70	$3 25	$20, 825 00
James T. Sloan & Co	1, 250 00	1, 000 00	1, 250 00	1 25	1 25	3 50	3 50	43, 550 00

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, January 20, 1871.

GENERAL: By letter from the office of the Chief of Engineers, dated July 23, 1870, I was charged, in addition to other duties, with the survey of the Cumberland River.

I placed Mr. S. T. Abert, civil engineer, in the immediate charge of this survey, and I herewith transmit his report. This is so full and explains the necessity for the improvement of this river so closely, that I think it necessary only to call attention to the fact that this river is second to none of the branches of the Ohio River as far as the necessity for improvement is concerned. It empties into the Ohio River only about seventy-three miles above the mouth of the latter. Between its mouth and the mouth of the Ohio there are but few obstructions to navigation in the latter river, and these few will probably soon be removed.

I therefore recommend that the sum of $450,000 be appropriated for the improvement of this river, and that the further sum of $8,000 be appropriated to enable me to complete the instrumental survey of the river from Nashville to the foot of the falls.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

LOUISVILLE, KENTUCKY, *January* 20, 1871.

Major G. WEITZEL,
Corps of Engineers, Louisville, Kentucky.

SIR: In compliance with your instructions, I have the honor to submit the following report of the survey of the Cumberland River:

The party when organized numbered twenty-one men, including two assistants, Mr. Edward Mead and Fr. Hellner. A small steamer was employed, as the most expeditious and economical means of making the survey. The entire party embarked at Nashville on the 1st of September, and returned on the 31st of October, 1870, having completed a reconnaissance of nearly two hundred miles, and having made a careful survey of all the important obstructions between Nashville and the mouth of the river.

As the upper part of the river, between Nashville and the head of navigation, flows through a fine agricultural district, as well as an important section of the coal-fields of Kentucky, the survey could not be regarded as complete if it omitted to notice this region. A small party was left in Nashville to complete the field-maps, while a personal reconnaissance was made of the river between Nashville and the falls of the Cumberland, a distance of four hundred and three miles.

In the following description of the course and character of the river, I have inverted the procedure of the survey, and have traced the river from its source downward.

The Cumberland River rises on the west slope of the Cumberland Mountains, and in the northeast extremity of Harlan County, Kentucky. Its course is an eccentric one. Instead of taking a northwest direction, which would have been perpendicular to the course of the highlands, and in conformity to the natural dip of the upper strata, its general courses, from its head to its mouth, is semicircular. Approaching Nashville from the northwest with three large convolutions, two-thirds of the length of which are parallel with the Cumberland highlands, it turns northwest at Nashville and finally terminates its course in the Ohio River, near the mouth of the equally eccentric Tennessee, in nearly the same latitude as its source. The Cumberland Mountains, which separate the water-shed of the Cumberland from the valley of Tennessee, have at this point an altitude of 2,600 feet above the sea.

Cumberland Gap is about 1,600 feet. With a rapid descent, the river reaches the first bench of the highlands, and, after a precipitous fall, it flows with a more equable current among the sub-carboniferous conglomerates of the highland plateau. Cutting its pathway through solid rock, it reaches, in Whitley County, about ten miles below Williamsburgh, the great falls of the Cumberland, where the entire river is precipitated over the conglomerate, with a vertical fall of 63 feet. Here, in a deep and rocky basin, at the foot of the falls, it stops to rest before pursuing its rugged course. Here, too, the surveys and plans of improvement usually begin. Although the river above the falls might be made navigable for barges for fifty miles by the removal of the dams which obstruct its course, the falls present an almost insuperable barrier to further progress. The produce of this section of country finds an outlet by the railroad from Mount Vernon to Louisville. This road, when completed, will cross the Cumberland at Williamsburgh, Kentucky, and will extend to Knoxville.

Before entering upon a specific description, the following tabular statement will give the more salient features of the river. The altitude above the sea has been determined by a comparison of railroad levels

Locality.	Distance in miles.	Height above mean tide at Mobile.	Descent or difference of level.	Slope per mile of the water surface.
Foot of the Falls	......	770.70	....	....
Laurel River	10	685.70	85.	8.5
Head of Smith's Shoals	24	651.70	31.	1.42
Foot of Smith's Shoals	9	597.70	54.	6.00
Point Burnside	2	597.00	0.7	0.35
State Line	129	502.50	94.5	0.73
Nashville	229	365.00	137.50	0.60
Mouth of the river	192	286.00	79.00	0.41
Total	595	....	481.5	....

From the head of navigation to the mouth of the river is about five hundred and fifty miles; of this distance, one hundred and twenty-nine miles of the upper and seventy-five miles of the lower part of the river, or two hundred and four miles in all, are in the State of Kentucky, and three hundred and four miles in the State of Tennessee. As the slope of the river varies considerably in different parts of its course, it produces a corresponding variation in the range between high and low water. At the falls the range is not known. At Point Burnside it is 65.5 feet; at Nashville the high water of February, 1847, was 52.9; of March, 1867, 50.3 feet. An ordinary rise of 33.8 feet at Nashville is equivalent to fifteen miles at the foot of Smith's Shoals, and to five miles at the head, or to what is called a "coal-boat tide," which is the stage of water at which the coal barges are just able to pass the rapids. At Goner's Island the range is 41.6 feet; at Harpeth Shoals, forty miles from Nashville, it is 39.3 feet; below Davis's Ripple it is 55.8; at Clarksville, sixty-five miles from Nashville, it is 56.3; at the Tennessee Rolling-Mills, one hundred and forty-five miles from Nashville, the high water of March 14, 1863, was 53.8; of March 14, 1867, 55.2. At the mouth of the river, one hundred and ninety-two miles from Nashville, and five hundred and fifty-two miles from Point Burnside, the range is 51 feet. As the great floods occur generally in February and March, before the crops are planted, the destruction from high water is not as great as takes place upon the Arkansas, the Red River, and the Mississippi, where the bottoms are less elevated, and where the greatest floods often occur in June and July.

From the falls to Point Burnside the river flows in a narrow gorge which it has excavated out of subcarboniferous sandstone, conglomerate, and cavernous limestone, at a depth of three to four hundred feet below the highland plateau. The river in this distance varies from 100 to 650 feet in width, but the gorge is more uniform, increasing gradually from 500 to 700 feet. In this part of its course the river is approachable by roads, which are exceedingly rough, resembling irregular flights of stone steps, hardly practicable on horseback, but exhibiting at every turn, as they descend the sides of the bluffs, wild and picturesque cliffs of rock. At Point Burnside the gorge widens, and bottoms appear of sufficient extent to be cultivable. The river continues to flow through a rocky bed with bluffs of limestone, and with a valley varying from one-half to one mile wide, as far as Carthage, where the valley extends upon the south side, into the Nashville basin. The river follows the northern edge of the highland rim, until it leaves the basin and re-enters the highlands about fourteen miles below Nashville. It continues to flow through the intersecting ridges and valleys of the highland rim, with bottoms about a mile wide and gradually increasing in length and encroaching on the bluffs of siliçeous limestone, until it enters the upheaved sandstone and coal of Livingston County, at its mouth. In the latter part of its course its width varies from 600 to 700 feet, and its banks, when composed of alluvion, begin to exhibit evidences of change, which shows itself in the bars.

Before entering on a more minute description, the course of the river may, for convenience, be divided in three general divisions:

The first division extends from the great falls of the Cumberland to Point Burnside, a distance of forty-five miles.

The second division extends from Point Burnside to Nashville, a distance of three hundred and fifty-eight miles.

The third division extends from Nashville to the mouth of the river, a distance of one hundred and ninety-two miles.

FIRST DIVISION.

From the falls to the mouth of Laurel River, the Cumberland, as has been stated, flows between cliffs of subcarboniferous sandstone and conglomerate, which rise occasionally in escarpments, from a mass of débris at the base, to the height of 300 or 400 feet. The top of the bluffs forms the plateau of the Cumberland highlands, which extends northeast through Virginia and Pennsylvania to New York, and southwest through Tennessee into Alabama, with an entire length of seven hundred and fifty miles. Its height near the falls of the Cumberland is 1,190 feet above mean tide at Mobile, and descends to between 500 and 600 feet, at the Alabama line. This plateau forms part of the rim of the Nashville basin, and its area, in the States above mentioned, is coextensive with the most valuable coal-fields of Alabama, Tennessee, Kentucky, West Virginia, and Pennsylvania. Large masses of conglomerate, which have fallen from the bluffs, obstruct the course of the river and indicate its destructive power, as the falls have slowly receded to their present position. Some of these masses are from 50 to 60 feet, cubed, and occur in such numbers as to break up the river into narrow, irregular currents, and render it impassable for a canoe.

A descending navigation in this part of the river can only be made by an expenditure of money wholly disproportionate to population and productive character of the adjacent country. The distance from the falls to Laurel River is ten miles, and the descent at low water 85 feet, or at the rate of 8.5 feet per mile. The channel is from 150 to 180 feet wide, and at several points it is even reduced to 30 or 40 feet.

From the mouth of Laurel River to Smith's Shoals, which is the most serious obstruction in this division, the distance is twenty-four miles and the descent 31 feet, or nearly 1.3 feet per mile. In this part of the river the tops of the bluffs are capped with sandstone and conglomerate, the river having cut its way into the cavernous limestone.

The elevation of the bluffs is not so great as in the previous section, between Laurel and the falls, but the country is equally broken near the river by ridges and ravines, shut in by vertical walls of sandstone or conglomerate. The ravines, on account of their depth and narrowness, might be compared to cañons. The tops of the tall hemlocks reach to the feet of the traveler as he rides along the brink. The sides of the ravines are clothed with the dark-green foliage of the ivy and laurel, mingled with cedar and arborvitæ. The bluffs upon the river are similarly adorned, and overhang the water at many points for 30 feet or more. At one point a creek, which disappears at some distance from the river in the plateau above, enters near the surface of the water with a volume sufficient to turn a small grist-mill. A saw-mill, in this part of the river, supplies the material for the coal-barges at $15 to $20 per thousand. Rockcastle River enters about three or four miles below Laurel, and although the veins of coal appear near the surface of the water at this point, it cannot be profitably mined on account of the shoals. About ten miles below Laurel the coal-bed is about 250 feet above low water, and here a deep channel affords facilities for building and loading the coal-barges.

As the improvement of Rockcastle River is often spoken of in the vicinity, I would say that the survey made by the State proves that it is not practicable. The descent for fifty-two miles is 207 feet, or at an average rate of 4 feet per mile, but the actual fall is confined to shorter distances, and at one point amounts to 21 feet in four-tenths of a mile, and for a considerable distance its course is a succession of cascades. At another point the entire river at low water flows under a bridge of rocks. The trade of the country is very limited, and the cost of removing rocks, snags, and logs would amount to $1,000,000.

Below the mouth of Rockcastle River, the Cumberland is divided into a succession of pools and rapids; the pools vary in depth from 4 to 6 feet at low water. One or two of them are from 20 to 30 feet deep. The barge-builders take advantage of these deep places to turn their barges, which are built with the bottoms uppermost. At the shallow points, 6 inches may be found at low water. The bars are composed of rocky débris and large gravel, resting on a rock bottom. The work on this section will consist in removing several bars and fish-dams and blasting detached rock and projecting masses. The obstructions to descending navigation are small in comparison with those which occur at Smith's Shoals, which come next in order.

Smith's Shoals.—The name of Smith's Shoals, or the Great Shoals, has been applied to a succession of rapids, caused by the descent of the river over ledges of shaly limestone, and designated successively Shadowen Shoal, White Cliff Ripple, Long Shoal, and Smith's Shoal. These shoals are the most dangerous obstacles to descending navigation, and before the channel had been improved, as many as ten to twelve coal-boats have been lost out of forty, which attempted to descend during a freshet. Since that period a large amount of rock has been removed from the channel, and the loss of coal-boats does not exceed three annually. The entire length of the shoals is nine miles, and the aggregate descent 54 feet, or at the rate of 6 feet per mile. As the river below the shoals has a very moderate descent, a rise of 13½ feet at the foot is equivalent to 1-foot rise at the head of the shoals. When therefore the river is high enough for boats to run the rapids, the slope is reduced to about 44 feet, or to nearly 5 feet per mile.

Shadowen Shoal, the first of the series, is formed of horizontal ledges of limestone, fractured and seamed by the current, over which the water flows with a depth varying little from 3 inches, when the river is about 1 foot above low water. Here the river expands from a width of 400 to 700 feet, and continues nearly the same width throughout the length of the shoal. The length of Shadowen is two miles and the descent 10 feet, or at the rate of 5 feet per mile.

A vertical cliff of limestone, two to three hundred feet in height, gives the name to White Cliff Ripple, which is three miles below the first. It is about one-fourth of a mile long, with a descent of 25 feet, or at the rate of 10 feet per mile. The width of the river is about 600 feet. It resembles the first.

Long Shoal is separated from the last by a pool, three-quarters of a mile in length. It has the same bottom as the others, but varies in width from 600 to 660 feet. It is one mile and seven-tenths in length, and has a descent of 21 feet, or at the rate of nearly 13 feet per mile, but at one point there is a vertical fall of 2½ feet. The contraction of the water-way, the rapid descent, and the sudden turn to the left which occurs at this point, make the passage more dangerous than at any other part of the shoals. Three lateral dams have been built in this bend. All of them enter the river nearly perpendicular to the current, and two of them are provided with flank walls. The stones on the upper one have been scattered by the floods. These dams were not intended to influence the low-water stage, and their utility, on account of their position, is doubtful at high water.

Smith Shoals is about one-fourth of a mile lower down. In length it is three-fourths of a mile plus 478 feet, and has a descent of 15 feet, or at the rate of 17.6 feet per mile Three lateral dams, or wing-dams, have been built in this bend, two from the righ bank and one from the left. The upper dam on the right and the dam on the left have flank extensions. In this shoal there is a vertical descent of about 2 feet, but the danger is not as great as in the Long Shoal. Some of the dams were constructed by the United States and part by the State of Kentucky, at different times, and quite a large amount of rock has been removed from the channel. The rock excavation has been of undoubted benefit, but the utility of the dams has been questioned. While increasing the depth of water, they have, it is said, at the same time increased the turbulence of the current, and the coal-boats are sometimes sunk by the waves which dash over the sides.

To secure the safety of the descending navigation, it will be necessary to distribute the descent where the fall is greatest, by excavating the channel. If dams are erected, they should be placed in the still water of the pools below the shoals, so as to reduce the descent, without dangerously increasing the velocity of the current.

A canal would afford a secure transit both for ascending and descending boats in ordinary stages of the river, and would cost about $1,500,000. A slack-water navigation, by means of locks and dams, would be equally efficient, but not so durable. It would cost about $900,000, or about $15,000 per foot rise for 66 feet, which, with four or five dams, would give at low water about 3 feet of water in each lock. These estimates are not included in the final statement. The improvement of the natural channel by contraction or excavation has been alone considered, on account of the cost of other methods of improvement.

A descending navigation is practicable by the latter method in this part of the river. The coal-boats receive their loads during the fall months, and are tied up to wait for the winter floods. Upon the appearance of a sufficient "tide" they start in rapid succession. The race is exciting, but not dangerous to life. If the boat is wrecked on the rocks, or swamped by the waves, the boatmen float ashore on the large oars, which are made of poplar and are very light.

Throughout the length of Smith's Shoals the bluffs, between 300 and 400 feet in height, are conspicuously escarped; the escarpment is sometimes on the right, sometimes on the left, but always opposed to the direction of the current. The rock, when not stained by oxide iron, or pink lichen, is of a light-gray color. The débris at bottom affords a foothold for trees, and the bluff on the opposite side is partially concealed by trees and clinging shrubbery. Two narrow strips of bottom, one at the foot, and the other about one-half a mile below the shoals, are cultivated. From the foot of the shoals to Point Burnside, a distance of two miles and a descent of $\frac{7}{10}$ of a foot, or at the rate of 3.5 feet per mile, completes the first division. The removal of some logs is sufficient to make this distance safe for steamboats.

Before commencing the description of the next division, a few words may be given to the Great South Fork of the Cumberland, which enters at this point. This branch is regarded by some persons as of sufficient importance to dispute precedence with the main stream.

The Great South Fork.—This fork has been surveyed under the authority of the State of Kentucky. The following statement of distances and descent is taken from the report of that survey: From Little Jumps, a narrow rocky gorge, to the mouth of the river, the distance is about thirty miles, and the descent at the rate of 2¼ feet per mile. The width varies from 50 to 200 feet except at Messer's and Sloan's Shoals, where the width varies from 200 to 400 feet. In this distance are two rocky bars and two shoals composed of ledges of rock, which have just been named. The descent of these shoals is about 15 feet to the mile. This part of the fork could be improved by lateral dams and excavation, for the sum of $10,900. But the best coal is found above Little Jumps and between Little and Big Jumps, a distance of fourteen miles, and here the obstacles are very formidable. At Big Jumps the channel is filled with large rocks for a distance of 400 feet. The descent of the river between these two points varies from 7 to 14 feet. The channel is narrow, and its course so crooked that a loaded boat could hardly descend at high water with safety. At one point during low water the river disappears, and, sinking into a subterranean channel, reappears two miles below. Here, where improvement would be most costly, the best veins of coal are found. The work above mentioned is not included in the estimate for improving the Cumberland.

SECOND DIVISION.

From Point Burnside to Nashville, the head of low-water steam navigation, the distance is 358 miles, and the descent 232 feet.

The line of the proposed railroad from Cincinnati to Chattanooga crosses the river at the head of this division, and ascending the ridge east of the South Fork attains the highland plateau upon which, with an imperceptible descent, it extends to the State line of Georgia. From Point Burnside to the dividing line between Kentucky and Tennessee the distance is one hundred and twenty-nine miles, and the descent 94 feet, or at the rate of 0.73 of a foot to the mile. In this section, in ordinary high stages of the river, steamboats encounter difficulties at nineteen or twenty points, consisting of rocky ledges, gravel-bars, and snags or logs, and overhanging trees. At low water the pools become nearly level, the bars more numerous, and the descent is transferred to the shoals and rapids. At this stage an improvement of the natural channel by contraction and excavation is impracticable. When the river is from 6 to 8 feet above low water this method may be applied with advantage.

For the first forty-five miles between the South Fork and Creelsborough many shoals and bars are observable. The descent in this distance is 0.74 of a foot per mile, and the width of the river varies from 350 to 400 feet. A gravel-bar at Fishing Creek, and a rocky channel at Cowan's Shoals, offer but little impediment.

The first point which requires attention is found at Forbush's Bar. The channel near the left shore is swift for about 1,600 feet, with rocky rapids at the head and foot. A reef below deflects the channel to the right. Some rock excavation to distribute the descent, and a dam, is required at this point.

The next point requiring attention occurs at Harmon's Shoals. Here the water spreads over a shallow reach. Some rock excavation, and a dam 1,000 feet in length are required to improve the navigation at this point. Passing Garn's Island, where the main channel on the right is partially obstructed with rocks. The next point which deserves attention is found at Lilly or Wolf's Island. The left chute is closed at low water, and the entrance to the main channel is obstructed by a ledge of rocks. A short dam to back the water, and the removal of the rock, is all that is required at this point. Passing Belk's Island, which has a narrow channel on the right 80 to 100 feet wide, the next point for operations is found at Wild Goose Shoals. Here the channel turns suddenly to the left, near the middle of the shoal, being diverted by a gravel-bar, at the mouth of a small creek. Some rocks appear at the upper and lower end, 1,500 feet apart, which require removal. A dam 1,000 feet in length should also be erected. Change has taken place in this part of the river since Stansbury's survey. The position of the rock and gravel has been inverted; the rock is now exposed on the left of the channel and the gravel on the right.

The railroad of the Poplar Mountain Coal Company reaches the river at Indian Creek, fifty-four miles from Point Burnside, and three hundred and four miles from Nashville. It requires a 10-foot rise to permit a "tow" drawing 6 feet to go down the river with safety. The largest "tow" ever dispatched from this landing carried 42,000 bushels coal. Six days are required to make the round trip, (including bringing the barges back,) if the boats are not detained by fogs. The obstructions to this trade are found in the bars of débris of rocks and ledges, and in the crooked channel. Blankitship bar and Campbell's Island come next, but are not of sufficient importance to require further notice.

From Creelsborough to Burksville the distance is twenty-six miles, and the descent 16 feet, or at the rate of 0.61 of a foot per mile. The average width of the river is 450 feet. In the upper part of this section the only improvement required consists in removing some logs and trees.

The next point requiring improvement is at Walton Shoals. This is a straight and shallow "reach," and should be contracted by a dam.

From Burksville to the Tennessee line the distance is forty miles, and the average descent 0.74 of a foot per mile. The width of the river increases gradually to this point, where it is 550 feet. Six islands in this part of the river divide the water-way, but, with the exception of the removal of a small amount of rock, no work is required. From South Fork to this point the alluvial banks, between the bluffs, are about fifty feet in height.

From the State line to Nashville the distances depending on a comparison of reconnaissances, and the distances as estimated by the pilots, are as nearly correct as was possible without actual survey. From this line to Carthage the distance is about one hundred and twenty-six miles, and the descent 74.4 feet. The following points deserve notice: Passing Turkey Island and Brimstone Island, where the channel is very crooked, the next point is found at Floating Mill, or Scantlin Island. The steamboat channel has changed since Stansbury's survey from the right to the left. Removal of rock and the erection of a dam is necessary at this point. At Simpson Island the channel is divided by three islands, two on the right and one on the left of the main channel. Three small dams are necessary to unite the adjacent islands, and to close the lateral chutes above. At Cub Creek two islands should be united and connected with the main shore. At the mouth of the creek, rock and gravel excavation is required. No work is now required on the bar near Williamsburg, Tennessee. At Cribbins, or Widow Holliman's Island, a dam should be erected to unite the upper island with the shore. The next point occurs at Indian Creek. A rapid descent and rocky channel render a dam and rock excavation necessary to improve the navigation at this point.

Very serious obstructions are found at Sand Shoals. The channel is obstructed by one large gravel-bar, and several smaller, and the lower end is partially occupied by rock. A dam 2,500 feet long, dredging, and the removal of rock will make this channel less difficult.

Rock, Bush, and Beasley's Shoals all present obstructions, but do not necessarily require improvement at the stage to which operations of this kind are applicable.

From Carthage to Nashville, a distance of about one hundred and three miles, many bars are revealed at low water. Bartlett's Bar and Donaldson's Horse-ford should receive attention. Dams are required at both points, and the gravel-bar at the last point might be dredged with advantage.

From Carthage down to Nashville the following bars are merely named in their order: Carthage Island, Foster's Island, Hanging Rock Island, Bartlet's Island, Parker's Island, Goose Creek Island, Witly Island, Bartlet's Creek, Donaldson's Horse-ford, Burke's Ripple, and several others of unknown names.

The width of the river from the State line varies from 550 to 660 feet, and the descent to Nashville is at the average rate of 0.59 of a foot per mile. The bottoms are from one-half to one mile wide. At Carthage the bottoms expand on the left or south side into the Nashville basin. This remarkable basin is one hundred and twenty miles long and fifty to sixty miles wide, and extends longitudinally in a southwest direction. It lies wholly in the State of Tennessee, and contains the most flourishing cities and some of the most fertile lands in the State. Its surface, resting on silurian limestone, is undulating with isolated ridges or small hills, which rise occasionally to the level of the summit of the surrounding highlands. It is difficult to conceive of this basin as the result of erosion and aqueous denudation, but no other cause has left such unmistakable evidences of its action. Throughout the entire area of the cavernous limestone its operation is conspicuous. The conglomerate which covers the limestone and forms the surface of the highlands possesses extreme compactness and strength, and at the falls of the Cumberland has for ages resisted the action of rapid currents. After the water had once penetrated this rock, and reached the limestone, the caverns of the latter must have supplied subterranean reservoirs for the accumulation of the water.

Before the water was able to find vent, the increasing hydrostatic pressure must have been proportionate to the subterranean area, multiplied into the height of a column, which, in the highland, must have varied from 400 to 600 feet. This enormous pressure would have been sufficient to have rent asunder the rock and to have opened channels for powerful currents. Evidences of this action are not confined to the Nashville basin, but are coextensive with the conglomerate and underlying cavernous limestone. It may not only be observed in the cañon-like ravines, the rock-bridge of Rockcastle River, the subterranean channel of the South Fork, the deep gorge-like valleys of the Cumberland and its tributaries, but also in the course of the Tennessee after it enters the same formation, and it is equally conspicuous in the denudation, down to the lower silurian, which characterizes the southern border of the blue-grass region of Kentucky.

The strata of the basin, composed of lower silurian, passes below the bed of the river below Harpeth Shoals. This dip controls the course of the river in its efforts to flow to the northwest, but the southwest direction of the greater part of its course may have been determined by the surface of the superincumbent conglomerate through which it must have cut its way before reaching the silurian limestone. The course of the tributaries is also controlled by this formation. All these streams have a general northwest direction. Caney Fork is worthy of note, because of the deep and rocky gorge and a vertical fall of 90 feet, by which the creek descends from the highland rim and enters the basin.

THIRD DIVISION.

From Nashville to the mouth of the river the distance, as determined by reconnaissances, is about one hundred and ninety-two miles; the descent by railroad levels is 79 feet, or at the rate of 0.41 of a foot per mile.

The obstructions in this division consist of rocky ledges in the upper part, and of brittle ferruginous conglomerate and gravel and sand in the lower. There are also snags and logs which should be removed. Four bridges cross the Cumberland in this division. Two at Nashville—a wire suspension-bridge and an iron railroad draw-bridge of the Louisville and Nashville Railroad. The third is at Clarksville, on the Louisville and Memphis Railroad, and is a draw-bridge of composite character, partly iron and wood. The fourth is in process of erection near the mouth of the river. The channel-way has a clear distance of 115 feet at all these bridges.

The first point requiring attention below Nashville, after the removal of the foundation of an old pier at the city, is found at Nashville Island, two miles below. Several rocks, which obstruct the passage of the boats, should be removed from the channel. The island can, without difficulty, be connected with the left shore, and the increased volume of water would enable the boats to pass safely to the right of the island. But the same result can be accomplished at less cost by removing the rock, which is about 6 inches below the surface at low water. This rock appears to form part of the bed of the river. The main body of water is deflected into the right-hand channel by a bluff of rock, which extends above the landing, below the chair factory. The opposite bank is much worn by the current, and should be protected. The average slope per mile, from the head of the island to the fish-trap below, a distance of 7,300 feet, was 2.14 feet; the maximum descent near the middle of the island was 6.35 feet, and the depth at low water on the bar is 1.2 feet.

From Nashville Island to Gower's Island the rocky banks have been worn by the water as smooth as a slope wall, and follow the course of the river with a regular curvature. A high bluff appears on the right, above the island, and here the river valley contracts, and the highland rim is again entered. The work required at this point consists in the removal of a portion of some cribs and wrecks. The channel on the left of the island is narrow and may require dredging.

Harpeth Shoals.—A succession of rocky ledges and gravel-bars, severally known as Flax-Patch Bar, Harpeth Island, Sycamore Creek, Harpeth River Bar, and Reed's Reef, are collectively designated Harpeth Shoals. These obstructions have been regarded as among the most serious on the river on account of the number and close succession. The entire length is 4.3 miles; the total descent 11.59 feet; the average slope per mile 2.17 feet, and the maximum slope 7.81 feet, which is near the lower part of the island. The shoals are probably formed by the increased dip of the strata. The work executed by the Government in 1834 has increased the depth of the water, but the lateral dams constructed at that time are greatly in want of repairs. Openings have been made in them by fishermen, to secure a passage for their canoes, and a large amount of water escapes behind the dams.

The first dam at Flax-Patch Bar is formed by loose stone (riprap) cast in along the line and rising to 5 feet above low water. The river is contracted by the dam from 720 to 320 feet. Entering the river obliquely, this dam extends for 530 feet to the angle, and then runs parallel with the current for 860 feet, terminating abruptly. Below, the channel crosses to the left over a gravel bar, with one foot upon it at low water.

Harpeth Island Dam commences about 1,700 feet lower down, and enters the river from the same bank, but more obliquely. From the bank to the angle, the distance is 800 feet; the island is 3,100 feet in length, and the dam extends, in a damaged condition, 1,600 feet below the end of the island. The entire length, including the island, was originally 5,500 feet. The water-way is contracted from 775 feet above the dam, to 450 feet near the upper, and 375 feet near the lower end. At the stage of 2.2 feet above low water, the maximum velocity above the Flax-Patch Dam was 1.72 feet per second, and about the middle of Harpeth Island the maximum velocity, about the same stage, was 3.48 feet per second. At this stage the Flax-Patch Dam was found to have raised the water 0.68 of a foot near the angle, and the Harpeth Dam 1.70 near the angle, and 0.87 near the foot of the island. The discharge of the river above Flax-Patch Dam, when the gauge read 2.2 feet, was 4,971 cubic feet per second, and the discharge near the middle of the island was 4,810 cubic feet per second; the difference between the two, 161 cubic feet per second, is equal to the quantity of water which escaped at the head of the island. Below the island the dam has been nearly destroyed by the steamboat men, in their efforts to warp up against the current. The stone has been used to give weight to the anchors employed for this purpose. If a dam is ever reconstructed at this point, it should be supplied with ring-bolts, firmly anchored in masses of rock. The contraction of the river has caused considerable abrasion of the banks, which should be protected. It has been stated that the deepest channel was originally on the left of the island, but that the engineer, fearing the formation of shoals below from the lighter gravel of this channel, threw the body of the river over the horizontal bottom of rock which composes the bed of the right channel; 2,500 feet below, the channel crosses to the left over a gravel bar and some detached rock opposite Sycamore Creek. From the creek to Harpeth River the channel is obstructed by detached rocks which have fallen from Harpeth Bluff. Opposite the mouth of Harpeth River a projecting reef and an irregular rocky bottom, for 150 yards, are the chief impediments. At Reed's Reef two rocks, one on each side of the channel, contract the water-way and make the channel difficult to pass at low water. In order to restore and improve the navigation at these points, the old dams should be repaired and extended, the rock removed at Sycamore Shoals, and the bar dredged. If these operations are insufficient a dam will be necessary. The rocks in the channel in front of Harpeth Bluff should be removed, and also portions of the reef opposite Harpeth River, and the irregularities of the bottom should be leveled.

The rocks at Reed's Reef should be removed from the channel. Until this work is executed, it is not easy to determine whether a dam should be placed near the mouth of Harpeth River, or below Reed's Reef. This question can be but determined during the progress of the other operations. Good cultivated bottoms, from three-quarters to one mile in width, are found on each side of the river about Harpeth Island, and continue as far as Harpeth Bluff on the left, and to the bluff below Reed's Reef on the right, with an elevation of about 35 or 45 feet.

Between Reed's Reef and Davis's Ripple the alluvial bottoms increase in extent, both in length and breadth, but no serious obstruction is formed as far as the latter point.

Davis's Ripple.—The average slope from a small ravine above the dam to the landing below, a distance of 1.34 miles, is 3.77 feet per mile; the maximum slope near the lower end of the dam is 9.16 feet per mile. The dam enters the river at an angle of 45°, and extends 420 feet to the angle, where, turning, it continues down stream for 850 feet, terminating abruptly. The width of the river is contracted from 520 feet above the dam to 240 feet, at the middle of the flank wall. This dam is of riprap, and, like the others, is about 5 feet above low water. Several gaps and a break near the shore permit the water to escape. A gravel bar extends below the dam, which has a depth of 1.4 feet at low water. A gravel bar at the mouth of a small branch contracts the channel opposite the lower end of the dam, and creates a rapid, oblique current. The repair of this dam and the dredging of the gravelly point will reduce the current and improve navigation at Davis's Ripple. A high bluff on the right contains good hydraulic limestone. Below this point gravel bars become more frequent, particularly at the mouths of the creeks. Those which occupy the bed of the river, are said to have retained their present form for twenty years. Any obstruction in the current becomes, however, the nucleus of a rapid accumulation of gravel and débris. The wing-dams in this part of the river are said to become packed with gravel, and water-tight in two years after erection.

From Davis's Ripple to Clarksville, sixty-five miles from Nashville, the river winds in long and graceful curves, such as might have been designed by art. Throughout this section the dredge may be used with advantage, especially in connection with lateral dams. Natural circumstances favor the preservation of an artificial channel, which the stream cannot create. A straight part of the river walled in by rock on the right, just above Clarksville, is partially obstructed by brittle ferruginous conglomerate, which can be excavated with the dredge.

Approaching Palmyra Island, ten miles below Clarksville, the bottoms become lower and the banks are composed more largely of gravel and lighter alluvial. The change has increased the number of islands and bars in the river below Palmyra, Wells, and Bald Islands, composed for the most part of gravel, which the decreasing velocity of the river here leaves in the broad reaches and eddies. These islands continue to increase until, acting as artificial wing-dams, they contract the stream and augment the velocity sufficiently to maintain a navigable channel.

Palmyra Island.—The river is, at ordinary stages, divided into three channels, which at low water are reduced to two by the drying up of the middle channel, leaving a gravel bar on the right of the island. The left chute is 30 feet wide. The right-hand channel being very narrow, and turning sharply to the right, becomes, at the head, difficult to navigate on account of a cross-current which forces the boats on the bar opposite. A small amount of dredging will remove this difficulty. The bank also should be protected from the current, which has cut deeply along the slope. The middle and left hand channel may then be beneficially closed by a dam rising 5 feet above low water. The river turns to the right against a bluff below, and the island appears to have formed in the eddy of the conflicting currents.

Elk Creek.—The shoal at this point is due to the gravel and sediment brought into a sluggish part of the river, by a rapid little creek. The creek enters with a comparatively rapid descent between soft and sliding alluvial banks. The average slope per mile of the river is 0.94 of a foot. The maximum slope is not more than 1.35, and the width of the river is 585 feet. The banks of the creek should be riprapped to prevent the erosion and the transfer of sediment to the river. After the bar has been dredged, it may be necessary to construct a lateral dam to keep the channel open. The banks are from 30 to 40 feet in height, and the bottoms from one-half to one mile wide. From Palmyra to Dover no other obstructions occur of sufficient importance to deserve notice, except the submerged logs below Wells Island. The river in this section is made up of straight reaches and long curves of sufficient depth, with banks well protected by shrubbery. The river-bottoms when not cultivated are covered with hickory, shellbark, oak, gum, and beach. The undergrowth is pawpaw and dogwood. The border of the river is lined with willow and some cottonwood. Bald Island appears as a gravelly bar, covered by the river in ordinary stages, but requires no special notice. In front of the old Cumberland iron-works; the river is sluggish, but free from snags, and in good navigable condition.

The next point is found at Dover Island. The obstructions assume the form of rocky ledges, and a gravel bar in the right channel, and continue with interruptions as far as Dover's Landing, three miles lower down. The island is one mile long, connected with the left shore by a dam, and another short dam has been constructed about midway. The left-hand channel, originally the best, was probably condemned on account of its sliding banks. The left channel along the rocky bluff has a bed of rock, and is very shallow at low water. The current is rapid, the slope being 5.5 feet per mile. The average slope between the head of the island and Dover Landing, three miles below, is 1.82 feet. The width above the dam is 435; about midway of the island it is 250 feet. Notwithstanding this great contraction, the descent brings the rock of the bottom sufficiently near the surface at low water, (one foot,) to obstruct the passage of steamboats. The dam is broken near the shore, but at the time of survey, when the river was 2.4 feet above low water, it raised the water about 0.43 of a foot. Little will be accomplished by the repair of this dam, if the rock is not at the same time removed from the point in the channel where the descent is greatest. Below the island the river is about 500 feet wide, and retains this width as far as Dover Landing. In the upper part of the reach, a gravel bar of regular form extends for 1,900 feet, and contracts the channel to 400 feet at low stages. Below this bar a dam enters the river at an angle of 45°, and extends for 380 feet with a flank wall 1,200 feet long. The water-way is contracted to 280 feet. The water is deep along the dam, but below it the channel is broken by gravel bars. Just above the ferry a cross-current forces the boats out of the channel, as they pass over the bar (1.3 water) to the left shore. The dam should be extended nearly to the upper landing, and the bar below should be dredged in order to secure a straight and good channel to deep water below Dover Ferry. Observations were made at the dam above Dover, which give for the discharge of the river when the gauge read 1.9 above low water, 3,248 cubic feet per second.

The next point in order is found at Upper Gatlin Shoals. The channel here is winding Beginning with width of 420, it expands, as it turns to the right, to 610 feet, and again contracts to 420 feet as it turns to the left, 2,500 feet below. The bar extends from the left shore, and the channel on the right is narrow, shallow, and crooked. A dam to deflect and contract the current combined with dredging will remove the difficulty at this point. The maximum slope at Gatlin is 2.81, the average 0.74 of a foot per mile.

The point next in order occurs at Line Island. Here a dam 1,420 feet long connects the right shore with the head of the island, which it follows for a short distance, and then extends in front of it for a distance of 5,080 feet. Above, the river is 500 feet wide, but is contracted by the dam to a width of 320 feet. The maximum slope per mile is 3.38 feet; the average slope is about 1.50.

The water is raised by the dam near the angle to 0.51 of a foot. Along the course of the dam the elevation is affected by openings. The distances from the angle and the height of the water, as affected by the breaks in the dam, are as follows:

Distance from the angle, in feet.	Height raised.	Distance from the angle, in feet.	Height raised.	Distance from the angle, in feet.	Height raised.	Distance from the angle, in feet.	Height raised.
300	0.21	2,100	0.81	900	0.17	2,700	0.22
600	0.29	2,400	0.21	1,500	0.27	3,000	0.32

The channel is obstructed at two points. About half way of the channel some wrecks upon the left are in the way at low water, and near the mouth of a small branch, just below the dam, a bar has formed in the line of the channel, which has a depth of 1.9 at low water. This dam should be repaired and extended, and a small amount of dredging should be executed in order to remove the obstructions to navigation. The work of excavation executed by the Government in 1834, at Devil's Chute, has removed the obstacles which once existed at this locality.

Race-Track Shoal.—The obstructions here consist of a gravel bar, and several boats are sometimes detained by the shallow water. The river approaches Devil's Elbow, where it is suddenly diverted to the right by a horizontal ledge of limestone which projects into the river about 8 feet above low water. In the reach above the rock, the river has a width of 420 feet, which is reduced at ordinary stages to 310 feet at the rock, and expanded to 540 feet below it. Here, about 600 feet below the elbow, a gravel bar has formed on the right. The material washed out of the angle above the rock, and also below it, by the current which is precipitated over it at ordinary high water, is deposited at the point where the width of the river expands to 540 feet. The maximum slope per mile at this point is 3.38 feet, and the average slope included in the length of the bend is 0.71 of a foot. It is impracticable to straighten the river without a considerable amount of work. But this end can be partially obtained by blasting off the rocky point in the elbow, and filling the bend above with the material. The bar should be dredged and the river below confined by a lateral dam, to reduce the width, which increases to 700 feet.

An examination was made of the shoal at Little River. The maximum slope was at the rate of 4.6 feet per mile; the minimum slope was 1.11 feet per mile. A bar is making from the left shore, but as it has two feet of water on it at low water, no work is required until the other bars are raised to the same standard.

Shelly's Island.—An examination was made of the channel from the head of the island to a point below the rolling-mills, a distance of one mile and a half. The average slope per mile is 1.12 feet; the maximum slope is 5.22 feet. A bar is forming from the left shore below the island, which contracts the channel and acts as an artificial dam to preserve sufficient depth of water. No work is required.

Ingram Shoals.—Four miles below the mills and about one hundred and forty-eight miles from Nashville, the last formidable obstruction is found. From the head to the foot of these shoals is about three-quarters of a mile. The width of the river above is 560 feet, and expands to 640 feet near the middle of the shoals and contracts to 440 feet below. The average slope is 2.3 feet per mile, the maximum slope being 7.10 feet. This shoal is composed of gravel resting on blue clay. The river at this point is straight. Originally the channel passed from the left to the right side, but has been transferred wholly to the right by four sunken barges at the head of the shoal. About half way of the shoal and in the middle of the river a gravel bar extends for 1,300 feet, contracting the main channel to the width of 200 feet without increasing the depth. The shoalest part of the bar has 1.2 feet at low water.

In order to improve the channel at Ingram Shoal, it is evident that a considerable amount of dredging will have to be executed in order to make a lateral dam efficient. Both are recommended. There are several other bars and difficult channels in this division, which have been passed over in order to select those which most require improvement. Those which have been omitted are named as follows: Wood's Island, Martin's Shoal, Well's Island, Checkered House, and Bull Pasture Shoals, Yellow Creek Towhead, Wild Cat Shoal, Boyd's Shoal, McKnab's Bar; below Ingram there are Big and Little Eddy, Big and Little Horseford, and a rocky point four miles below Camp Rowdy.

Steamboats pass all these points without difficulty, when obstacles are encountered at all the localities recommended for improvement. Under the influence of the back water of the Ohio, this part of the river is subject to change, but in its present condition no improvement is required.

CHARACTER OF OBSTRUCTIONS AND THE IMPROVEMENT PROPOSED.

From the description above given of the obstructions to navigation, it is evident that they may be classed under the following heads:

1st. Overhanging trees in the upper part of the river and some logs and snags in the lower.

2d. Horizontal ledges of rock, revealed at low water, at points where the river passes from a higher to a lower level.

3d. Bars composed of the débris of the bluffs and of the bed of the river and of heavy gravel.

4th. Bars composed of a horizontal layer of ferruginous conglomerate of sand and gravel, found in the lower part of the river.

5th. Wrecks of barges and old cribs.

The ledges of rock and bars of rocky débris become so numerous above Nashville at low water, that any attempt to improve navigation at this stage, by contracting the channel or by excavating the bed, is impracticable. The only feasible low-water improvement is by locks and dams. This method might be adopted with advantage, as far as the dividing line between Kentucky and Tennessee. It would be an efficient method of improving the great shoals. But since it is excluded from consideration by reason of its cost, it becomes necessary to determine whether the improvement of the natural channel is not practicable at some other than the low-water stage. The river from Nashville to Point Burnside is navigable for steamboats at a stage varying from 6 to 8 feet, and from Poplar Mountain "tows" drawing six feet water can make regular trips when the river is 10 feet above low water. Any improvement of the natural channel must facilitate navigation at these stages.

Low water, according to pilots, is the stage which permits the passage of the smaller steamers, drawing one foot without freight. This may be called steamboat low water, and is one foot above the ordinary low water of summer. In this acceptation the words are used in this report. From the mouth of the river to Nashville navigation is practicable at from one foot to one foot and a half above low water; from thence to Carthage 4 feet is necessary; thence to Burkville, 5 feet; thence to Point Burnside, 6 to 8 feet. In this division the period of navigation is usually six months. Five months, with a depth of from 8 to 10 feet, is counted on by the pilots of the Poplar Mountain coal trade for their tows of 6-feet draught. Above Point Burnside a flood of 15.7 feet at the foot of the shoals, and 4.5 feet at the head, and 16.8 feet at the point where the coal-boats receive their loads, is requisite for the safe descent of the coal-barges from the coal-mines of Pulaski County. This stage of water is equivalent to 33½ feet at Nashville. The coal-barges which make the trip unassisted by the steamers are compelled to wait for the flood. If the river at this point could be so improved that the barges might take advantage of intermediate floods of less elevation, the shipment of coal would be largely increased.

It is evident, therefore, that the improvement of the bed of the stream may be made efficient, by adapting this method to the changing conditions of the river at different stages and in different sections. On account of the variation of the descent, depth, and navigable period in different parts of the river, a uniform standard of navigation is impracticable. The navigable period of each section can, however, be prolonged, and many of the difficulties and dangers which obstruct the navigation can be removed.

The following estimates are based upon the application of the method of improving the natural channel, modified by the conditions of each locality:

FIRST DIVISION.

From Laurel to Point Burnside, or the Great South Fork.

1,000 cubic yards rock excavation, at $3	$3,000 00
Removal of fish-traps	100 00
Smith's Shoals:	
Shadowen Shoal, 500 cubic yards rock excavation, at $3	1,500 00
White Cliff Ripple, 500 cubic yards rock excavation, at $3	1,500 00
Long Shoal, 1,000 cubic yards rock excavation, at $3	3,000 00
Smith's Shoal, 1,000 cubic yards rock excavation, at $3	3,000 00
Long Shoal, 7,000 cubic yards dam, at $2	14,000 00
Smith's Shoal, 7,008 cubic yards dam, at $2	14,016 00
Total	40,116 00

or about $9,000 for rock excavation, and $28,016 for lateral dams, at Smith's Shoals.

SECOND DIVISION.

From Point Burnside to Nashville.

Forbush Bar:	
Removing rock and timber	$500 00
7,703 cubic yards of dam, at $2	15,406 00
Harmon Shoals:	
370 cubic yards rock excavation, at $2	740 00
7,703 cubic yards of dam, at $2	15,406 00
Wolf or Lilly Island:	
3,081 cubic yards of dam, at $2	6,162 00
1,111 cubic yards rock excavation, at $2	2,222 00
7,703 cubic yards of dam, at $2	15,406 00
Walton Shoals:	
Dredging 3,703 cubic yards of heavy gravel, at $1	3,703 00
Simpson Island:	
Removing logs	200 00
Left shore, right shore, dams connecting islands, 3,854 cubic yards of dam, at $2	7,708 00
Cub Creek:	
3,852 cubic yards of dam, at $2	7,704 00
Cribbin's Island or Widow Holliman's:	
3,852 cubic yards of dam, at $2	7,704 00
Indian Creek:	
1,541 cubic yards of dam, at $2	3,082 00
372 cubic yards of rock excavation, at $2	744 00
Sand Shoals;	
15,408 cubic yards of dam, at $2	30,816 00
Bartlette's Bar:	
7,704 cubic yards of dam, at $2	15,408 00
Donaldson's Horse-ford:	
15,408 cubic yards of dam, at $2	30,816 00
Total	163,727 00

The work at different points in the second division varies in cost, generally, from $8,000 to $31,000.

If the work in this division was confined to removing dangerous rocks and reefs, the cost would not exceed one-half the above sum, and the improvement would undoubtedly lead to an augmentation of the amount of the river trade.

THIRD DIVISION.

From Nashville to the mouth of the Cumberland River.

Locality.	Cubic yards of dam, at $2.	Cubic yards of dredging, at 50 cents.	Cubic yards of rock excavation, at $3.	Logs, snags, and wrecks.	Total cost.
Old foundation at Nashville	....	....	....	$500	$500
Nashville Island	....	....	....	300	300
Gower's Island	....	400	100	....	300
Flax-Patch,Dam	3, 852	1, 482	....	....	8, 445
Extension of dam	17, 719	....	....	....	35, 438
Harpeth Island	771	....	889	....	4, 209
Extension below island	7, 704	....	200	....	16, 008
Sycamore Creek	7, 704	....	20	....	15, 468
Harpeth River	11, 556	....	20	....	23, 172
Reed's Reef	....	....	100	....	300
Dan's Ripple	3, 852	3, 704	....	....	9, 556
Elk Creek	1, 000	3, 704	....	....	3, 852
Well's Island	....	....	....	200	200
Palmyra Island	6, 163	1, 000	....	....	12, 826
Dover Island, &c	13, 867	200	....	....	31, 297
Gatlin Shoals	770	7, 408	....	....	5, 244
Line Island	3, 852	7, 408	....	....	11, 408
Race-Track	8, 889	3, 704	....	....	19, 630
Ingram Shoals	23, 112	8, 888	....	....	50, 668
Total	110, 811	43, 624	1, 429	1, 100	248, 821

Cost of improvement in third division	$248, 821
Total cost of second division	163, 727
Total cost of first division	40, 116
Cost of improving the Cumberland River from the head of navigation at Point Burnside to the mouth	452, 664

This sum, $452,664, represents the aggregate cost of improving the Cumberland River, if the work is executed by the Government. Under the contract system the above amount would be increased at least 20 per cent. It would be economical to complete the third division first, and the second and first divisions subsequently.

An estimate based on the value of the proper machinery, tools and laborers, mechanics, and officers, numbering one hundred men in all, during a year of operations, would amount to $88,000 or $100,000. It may be necessary to contract the work to a less sum. Portions of the improvement can be executed with advantage to navigation.

The rock excavation at Smith's Shoals will cost about $9,000. This work might be executed without the dams, which would cost $28,016.

Below Point Burnside the cost of the work at different localities varies from $8,000 to $30,000.

Between Nashville and the mouth of the river the removal of wrecks will cost about $1,200. The repairs of Harpeth and Flax-patch Dam will cost $18,000, and the improvement, including the extensions of the dams of the entire series known as Harpeth Shoals, will cost $51,000.

The different shoals in this division will cost from $4,000 to $51,000 to place them in a navigable condition.

TRADE AND RESOURCES.

In order to exhibit the value of the trade of the Cumberland River, it will be sufficient to state the more important interests which would be fostered and developed by increasing the facilities of navigation. Among the first in importance and first in position is the coal trade. The eastern coal-fields of Kentucky form part of the coal-measures of the Cumberland highlands, which extend northward through West Virginia and Pennsylvania, and southward, through Tennessee, into Alabama. In Eastern Kentucky the area of coal-measures is about 8,900 square miles, and consequently exceeds that of Great Britain by eight hundred square miles, and is greater than that of France, Spain, and Belgium together. In Tennessee the coal area is equal to five thousand one hundred square miles, but it is not immediately available for the river trade. Those portions of Kentucky which have contributed to this object lie near the head of navigation, and extend from Clinton County to the eastern border of Pulaski County, a distance of about ninety-five miles.

The coal of this region, with few exceptions, belongs to the subconglomeritic or lower coal-measure, and like the coal of Arkansas, of the same horizon, is remarkable for its excellence and extent. The two latter circumstances have corrected the erroneous opinion formerly entertained of this formation, and have established the inapplicability of the distinction between the productive and barren coal-measures, which possess a local propriety when applied to the coal-fields of England and Pennsylvania. It was, however, known more than thirty years ago that a coal-basin, 1,000 to 1,500 feet thick, existed in Portugal below rock characterized by silurian fossils. In the State of Kentucky, in the subconglomeritic rock of the counties before mentioned, five veins of coal are found of easy access. But two only are generally regarded as workable. By denudation, the coal has been exposed in positions more suitable for working at some points than at others. From geological causes the beds thin out toward the east. The area of workable coal is, in consequence, circumscribed by certain districts. In Pulaski County it is divisible into three districts. The first lies between Buck Creek, seven miles above the Great Shoals and Rockcastle River. The second occupies a small basin between Buck Creek and Pittman Creek, and includes the town of Somerset. The third lies south of the Cumberland, between the falls and the South Fork. The first division includes the Cumberland coal-banks, now the most actively mined in the region above the South Fork. About half a mile above the mouth of Laurel, the coal was at one time mined on a small scale, but was abandoned, probably on account of the difficulty of handling the coal-boats and the scarcity of lumber with which to build them. Four veins of coal are found at this point: one in the bed of the river, another 20 feet above the water, a third, 35 feet above the water, and the fourth, 60 to 80 feet above the same level. The fourth is about 4 feet thick, but the third only has been worked. Another mine, about a mile below, on the left bank, was opened and abandoned. The principal "banks" are now found on the left bank, from ten to eighteen miles below the mouth of Laurel. As the subcarboniferous strata is nearly horizontal throughout the highlands, the subjacent coal has been exposed by the erosion, which has carved out into ridges a large section of country, and exposed the veins upon the sides between the associate strata of shales and conglomerates. The creeks and ravines, which are numerous along the river, afford many convenient points for reaching the coal-beds. The drifts are carried into the hills horizontally.

To buy the cars, build cabins and stables, lay the tram-ways, procure the tools, and to open a coal-vein, on the limited scale of those now worked, costs about $5,000. The tram-ways have a descending grade from the mines to the bluffs, a distance of one mile to one mile and a half, and are drawn by mules. The galleries are just large enough to admit a diminutive mule drawing six or eight small cars. The coal-boats are loaded by chutes, or by small cars sent down an inclined plane. The first mine in operation, below Rockcastle River, is mined by Mr. Allen Jones, the next by Mr. Elliot, and the third by W. Woodcock. There are others which are not now in operation. The first may be described as characteristic of the rest. The vein is from 4 to 5 feet thick, and about 300 feet above the river. The coal is a semi-cannel bituminous, rich in carbon, hard, shining, containing near the top of the vein delicate fibrous ramifications, or net-work of pyrites, easily selected from the mass as it leaves the mine. The coal burns with a lively, white, crackling flame, and is consumed to white ashes without swelling. It is justly regarded in Nashville as the finest coal brought to that market. It has also been employed at the iron-furnaces of Yateman & Woods, and is represented to have produced a larger and better quality of iron than the Pittsburgh or any other coal from the Ohio River. This testimony is confirmed by the former owners of the old Cumberland iron-works. The Cumberland coal consumed in and about Nashville, at the rolling-mills and for domestic purposes, amounted to 400,000 bushels.

When the first grade was erected in Nashville, in 1831, the consumption did not amount to 1,000 bushels. From 1836 to 1860 the price of coal by the boat-load was from 15 to 25 cents; by retail from 20 to 50 cents per bushel. It is now about 25 cents per bushel, of 80 pounds to the bushel, or $7 a ton. The demand, on account of the obstructions to navigation, has always largely exceeded the ability to supply the market. The mines are held chiefly by private owners, who limit their operations in order to supply the demand at the close of the winter, at which time only they are able to reach Nashville. The result is, the Pittsburgh coal, after descending the Ohio for nine hundred miles, is able to reascend the Cumberland for two hundred miles, and to compete in market with the Cumberland coal, of superior character, which has to descend the river for five hundred and fifty miles, not more than one-half of the distance. In 1860 it was estimated that 1,000,000 bushels, or 35,714 tons would be required to supply Nashville and the mills in the vicinity. This amount is now divided between different sources of supply, viz, Pittsburgh, the Cumberland River coal, and the Sewanee coal, from the Upper Coal Measures of the plateau, twenty-four miles north of the Alabama line, Grundy County. This coal is brought by rail to Nashville, a distance of about one hundred and six miles. It is evident from these facts that if it was practicable to circumvent the Great Shoals and to improve the navigation of the Cumberland between Rowena and Nashville, the coal from the upper river could be sold in the city in much larger quantities and at much lower rates. The larger investment of capital in mining operations, stimulated by the facilities of reaching market, would lead to so great an increase in mining operations that not only would the supply be sufficient for Nashville and the Cumberland River, but the Cumberland coal would be enabled to compete with the Pittsburgh and Ohio River coals upon the lower Ohio and Mississippi Rivers.

In the present condition of the river the coal-boats are obliged to wait for a "coal-tide." This stage is equivalent to 33.5 feet at Nashville, 14 to 15 feet at the foot of the shoals, 4 to 5 feet at the head, and 16½ feet at the coal-banks. At this stage barges drawing 4 feet may pass the rapids without much danger.

There are many tides of from 8 to 10 feet, which, in the unimproved condition of the river, are not available for descending navigation. The barges cost from $150 to $200, and carry from 6,000 to 8,000 bushels, or from 215 to 286 tons. These boats are sold in Nashville for $40 each. According to my information the cost of mining is about 3 cents per bushel, the miners making from $1 50 to $2 per day It costs two cents more to deliver the coal at the banks, and half a cent per bushel for loading, and half a cent more for pumping and bailing the boat. The cost of transportation and net value is as follows for an average boat-load of 6,000 bushels:

Value in Nashville of 6,000 bushels, at 25 cents		$1,500 00
Boat		40 00
		1,540 00
Cost of bringing to Nashville 6,000 bushels, at 6 cents	$360 00	
Boat	175 00	
Transporting	200 00	
Wastage	120 00	
Hauling	120 00	
		975 00
Net proceeds		575 00

The annual average shipment from the mines above Smith's Shoals is about 570,000 bushels, or 20,357 tons, equal in net value to about $57,000. The amount shipped from the mines since they were opened amounts to about 2,340,000 bushels, equal in value to $234,000 net. The second district, between Pittman and Buck Creeks, supplies coal for local purposes only.

The third district, bordering on the South Fork, has, on account of obstructions of the shoals, and large masses of conglomerate which block the channel, contributed but a small amount to the trade of the river. About seventeen miles from the mouth of the river a 3-foot vein was opened and worked for a short time. Between Big Sinking Creek and Little South Fork, about twenty-five miles from the mouth of the river, another vein, about 46 inches thick, was opened and subsequently abandoned. This vein is about 160 feet above the limestone, and over it 20 to 30 feet of shale, forming the top of the ridge. This coal is sulphurous. About half a mile above the Little Jumps much better coal is found, at Dick's banks, at an elevation of 350 feet above the creek. This vein is 46 inches thick and of excellent quality. The coal in the vicinity and above this point is abundant, and of the same quality as the upper banks of Pulaski County, but is naturally excluded from market by the obstructions to navigation in the South Fork.

Between Smith's Shoals, or the South Fork and Indian Creek, the landing of the Poplar Mountain Coal Company, below Rowena, fifty-eight miles from Point Burnside, coal has been mined in small quantities at several points. With the exception of the tops of isolated ridges, the entire area belongs to the so-called unproductive, or lower coal measures, below the "farewell" conglomerate.

The mines near Rowena have largely contributed to the river trade, and the company are preparing to extend their operations. The Poplar Mountain Coal Company is composed chiefly of Pennsylvanians; capital $250,000. The vein is 3¼ feet thick, and is about 900 feet above low water of the Cumberland, and therefore 1,357 feet above tide, or 480 feet above the main coal-vein of the Pulaski Banks. Unless the tilt of the strata has caused this elevation, the coal of this district must belong to a different vein; the coal of the Pulaski Banks has more of the character of cannel coal. This coal is taken from Short Mountain, a spur of Poplar Mountain, and is about seven and three-fourths miles from the river. The top of the mountain is about 1,100 feet above low-water, or 1,557 feet above mean tide at Mobile. About one hundred acres of good coal is found at this point. By extending the road to Poplar Mountain, two and one-half miles farther, a bed of coal is reached of superior quality, 3 feet 8 inches thick, covering 2,000 acres. The railroad is a substantial ballasted track, laid with T-rail, having a grade of 240 to 260 feet for four miles. A 23-ton engine is employed, which can draw from the mines to the river 1,200,000 bushels per annum. But the difficulties of navigation limit the quantity brought to market, which amounts to one-fourth the capacity of the road, or about 300,000 bushels.

Mining costs 3⅜ cents, transportation 1¾ cents, or 5⅛ cents per bushel at the landing. This coal is not handled from the time it is taken from the mines until it reaches the market, chutes being employed for landing. The method of shipping is likely to cause waste, but the coal is hard and the loss from this cause small. The demand largely exceeds the ability to supply. The round trip to Nashville and back again to Indian Creek requires six days, when not delayed by fogs. A rise of 10 feet at the coal-landing is necessary for a "tow," drawing 6 feet of water, and carrying from 35,000 to 42,000 bushels, to pass down with safety. The dangers consist in narrow and crooked channels and rocky obstructions. Two barges have been lost in four years. If the facilities of navigation were increased, a much larger amount of coal could be handled, with the same outlay. As in all other operations, the gross profit depends, not upon the increased value of the unit of measure, but in the increased quality of the commodity. One tow-boat, and the machinery now on hand, could bring to Nashville four times the quantity now handled. It is evident that the mines only await a more accessible market in order to become largely remunerative. The same company are now preparing to erect iron-furnaces. Throughout the coal region this valuable ore is found, affording from 35 to 60 per cent. of good metal. Below the falls of the Cumberland, in the stratum of shale below the conglomerate, and about 6 to 10 feet above the water, nodules of iron are found, notable from the fact that it at one time attracted considerable attention, in consequence of the widely disseminated report that this ore contained a valuable amount of silver. Visitors were attracted from other States, and the property about the falls was held at a high figure.

The following is a section of the bluff, commencing from the surface of the water at the foot of the falls: Seven feet of gray argillaceous and siliceous shale, with iron-stone; 12 feet of black shale, with nodules of iron-stone; 48 of conglomerate or pebbly sandstone, the pebbles of quartz often diffusely scattered and about the size of a small marble; the falls; 10 feet of conglomerate like the preceding; coal; conglomerate 10 feet; millstone grit 50 feet. The top of the bluff slopes back to 307 feet above its base. The foundation of an old school-house, about half a mile back, is 372 feet above the foot of the falls, and the top of the ridge is 422, or about 1,190 feet; above tide the general level of the higher ridges being 500 or 600 feet more.

The river flows through the subcarboniferous conglomerate and sandstone, in a trough of solid rock. Near Laurel it enters the subcarboniferous limestone, which has the cavernous character strongly marked, between Laurel and the head of Smith's Shoals. About the head of the rapids a bed of geodes is found near the low-water surface, containing beautiful specimens of crystals of quartz, carbonate of lime, chalcedony, and other minerals. The upper stratum of limestone contains fine specimens of crinoids, in large quantities, and near the water masses of limestone, composed of cyathophilloid corals, as if the entire reefs had been entombed in calcareous sediment. Terrebratula and other Devonian fossils are abundant. The limestone of this region affords good material for quicklime, as well as fine building-stone. The surface of the country, which is strewn with fragments of lithostrotion canadense, has been largely denuded of the sandstone and conglomerate. Near the mouth of the South Fork a bed of black bituminous shale probably marks the division between the Devonian and Upper Silurian. The geod bed, before mentioned, appears 50 feet above low water in the bluff below Point Burnside. About sixteen miles farther is a bed of limestone, which probably rests on the knobby sandstone, into which the river has cut deeply at Mill Spring. Before reaching the Tennessee line the river has cut down through the subcarboniferous sandstone and conglomerate, through the Devonian and Upper Silurian to the Lower Silurian. The bluffs about this locality are from 250 to 300 feet in height, and are denuded of the sandstone. All the stratas have a dip to the southeast, and are crossed by undulations whose axes lie southwest, and which together control the drainage of the country and the course of the Upper Cumberland.

The Nashville formation has an anticlinal west of that city, the strata on each side dipping, the one northeast, the other southwest. The northern border of the basin is formed by the highland rim and is composed of the siliceous mountain limestone, which is characterized by thin strata of chert, siliceous balls and fragments of lithostrotion strewing the surface. This formation is re-entered by the river between Gouer's Island and Ashland, forming the western boundary of the basin. The entrance of the river is marked by an escarped bluff, the light ocher tints of which are brilliantly illuminated by the morning sun, and hence called Rising Sun Bluff. Owing to the dip of the strata being more rapid than the descent of the river, the water-surface actually rises in the geological series in which it flows below Harpeth.

All the bluffs below this point belong to the siliceous group of the subcarboniferous limestone. Below Clarksville the bluff presents the following section: 40 feet of limestone at bottom, cherty and crinoidal; two beds, 30 feet and 48 feet, solitic and fossiliferous; 32 feet of lithostrotion limestone; 25 feet of siliceous cherty limestone, with small cavities; 30 feet of fossiliferous, cherty masses and soil containing lithostrotion.

This is a characteristic fossil. All the bluffs present the same general features. One stratum of limestone is characterized by black calcareous nodules, and the same black tint is sometimes observed in fragments of lithostrotion. In the clay and gravelly hills below the level of the ferruginous lithostrotion, from Clarksville nearly to the mouth of the river, brown hematite is everywhere found. This ore supplies a large number of furnaces, and the metal extracted is said to exceed in ductility and tensile strength that of any part of the United States, if Alabama is excepted.

The indications of this ore are everywhere observable in the red soil and sandy ferruginous strata and conglomerate along the banks and in the bed of the river. The ore at Yellow Creek takes the form of "pipe ore," and resembles the appearance of metal formed by the deposit from chalybeate water, percolating a honeycomb soil. It also occurs in ferruginous ocherous beds in the form of geodes, locally termed "pot ore." These are formed of oval concentric rinds of radially fibrous solid metal, which becomes less compact and more ocherous toward the outer surface. The concavities sometimes contain liquor and a muddy deposit. The inner surface is botryoidal, pisolitic, specular, black, or of a milky hue and iridescent. The cavities sometimes contain the casts of shells and fragments of cyathophilloid corals and crystals of sulphate of lime. The geodes weigh from several pounds to six tons. The muddy deposit has been analyzed and found to contain 0.4 to 0.8 per cent. of saline matter composed of sulphate of magnesia, lime, manganese, and iron, with a small proportion of chlorides. The position and form of the ore and the chemical analysis of the inclosed liquor seem to indicate its origin from the percolation of chalybeate water, which has taken the form of pipe ore in a honeycomb soil, and geodes in the concavities.

IRON MANUFACTURE.

The manufacture of pigs and rolling of iron at the furnaces and mills was, during the war, partly suspended. During that period the Cumberland Iron Mills were destroyed, but the Tennessee Mills, in Trigg County, Kentucky, continued their operations. Before the war there were in operation on the river twenty furnaces, producing annually 30,000 tons of pig-metal, 10,000 tons blooms, 5,000 tons bar and boiler-plate iron, the value of which was $1,680,000, the capital invested $1,216,000, and the men employed 3,500. The Tennessee Rolling-Mills turn out cold-blast, charcoal-bloom, bar and boiler iron of great strength and ductility, well adapted to engineering and mechanical purposes. It is claimed that the charcoal-iron produced at these mills from the brown hematite is of extraordinary tensile strength. As all these furnaces and mills are on the lower part of the river and are distant from the railroads, they are wholly dependent on the stage of the water for transportation. Trade is depressed from this cause. Large orders remain unfilled or are given to other parties, on account of the delay caused by the difficulty of navigating at low water. The present consumption of coal in and along the borders of the Gulf of Mexico amounts to 2,000,000 tons annually. The increasing number of steamships is creating a much larger demand for this article, and the application of iron in ship-building is causing a corresponding extension of the manufacture of this useful metal. The increasing demand for these minerals keep pace together, and both of them are found in large quantities in the States of Alabama, Tennessee, and Georgia. These States have the advantage of being five hundred to one thousand miles nearer to the Gulf than Pittsburgh, and since they produce an equal if not finer quality of coal and iron, they are destined to play an important part in the development of the trade of the Gulf of Mexico and the Caribbean Sea.

AGRICULTURAL RESOURCES.

Soils composed and resting on millstone grit are generally deficient in fertility, and this defect characterizes the land bordering on the upper part of the river, where it has not been denuded to the limestone. This soil yields, when first cleared, an average of 25 bushels to the acre, which has been raised by careful cultivation to 35 bushels. It is well adapted to the growth of fruit. The natural growth is chestnut, oak, yellow poplar, hemlock, or spruce pine, yellow pine, cedar, arbor-vitæ, holly, laurel, and ivy, which clothe with rich green the sides of the ravines of conglomerate. The finest springs of pure water issue from the rocks. Where the strata is denuded to the subcarboniferous limestone the country is marked by sink-holes and subterranean streams. Large springs are found at the base of the bluffs. The timber consists of white oak, beech, black, red, or post oak, cedar, walnut, poplar, and hickory, paw-paw, and grapevines. The red lithostrotion soils are nearly as productive as the river bottom. They are covered in the upper counties by black walnut, black oak, hickory, black gum, dogwood, and paw-paw.

In the Nashville basin and in the more fertile counties, the yield of corn varies from 50 to 80, and even 90 bushels; tobacco, from 1,000 to 1,600 pounds; and wheat, although of fine quality, from about 10 to 20 bushels to the acre. The climate is remarkably salubrious, especially upon the highland plateau. The average temperature at Nashville during the summer is 77.3°; during winter it falls to the average of 39.5°.

In the following statement of the trade of the river, the more important items only are given, on account of the difficulty of ascertaining the quantity and value of other articles. The aggregate without these is considerable. The total amount of tobacco brought to Nashville annually is—

4,114 hogshead, at $2 40	$987,360 00
2,057 lugs, at $1 60	329,120 00
Total tobacco	1,316,480 00
300,000 bushels corn, at 80 cents	240,000 00
Various freights, by careful estimate	2,000,000 00
Iron trade below Nashville	1,680,000 00
Lumber trade	500,000 00
12,000 barrels flour, at $6	72,000 00
870,000 bushels coal, at 25 cents	217,500 00
Annual value of river trade	6,025,980 00

Eight million twenty-five thousand dollars is less than the actual annual aggregate of the trade which passes over the Cumberland River, and is exclusive of the merchandise and machinery transported up the river above Nashville.

The number of steamers engaged in the trade between Nashville and other cities on the Cumberland, Tennessee, Ohio, and Mississippi Rivers amounts to about 26, averaging about 341 tons each, the aggregate tonnage being 8,870 tons. The average rates of freights the year round is, from Nashville to Louisville, 25 cents per hundred; to Cincinnati, about the same; to Pittsburgh, 50 cents; Memphis, 40 cents; Vicksburgh or New Orleans, 50 cents.

As the Cumberland has never been surveyed throughout its length, the distances are taken chiefly from the estimates of pilots. The following are nearly correct: From the mouth of the river to Point Burnside, the head of navigation, the distance is 595 miles; from Nashville to Smithland, 192; to Paducah, 204; to Cairo, 265; to Memphis, 500; to St. Louis, 450; to Vicksburgh, 900; to New Orleans, 1,300; to Evansville, 350; to Louisville, 600; to Cincinnati, 750; and to Pittsburgh, 1,250.

The boating season is generally six months, but sometimes below Nashville reaches to nine months.

There are eighteen to twenty towns and cities on or near the river. The two most important are Clarksville and Nashville, the first on the railroad line from Louisville to Memphis, the latter on the line of the road to Chattanooga.

Clarksville has about 8,000 inhabitants. The county of Montgomery, in which it is situated, is one of the most productive in the State of Tennessee. The city mills turn out about 60,000 barrels of flour annually, and 15,000 to 20,000 hogsheads of tobacco. The annual exports amount to $4,000,000, and the value of the aggregate business is $1,724,000.

The population of Nashville, exclusive of the opposite town of Edgefield, is about 30,000. The capitol overlooks the surrounding valley from a commanding eminence, and the site of the city is not only beautiful, but, from the rocky sub-stratum and good natural drainage, is very salubrious.

The entire business amounts to $41,869,000. Among the most important items of this sum are: cotton, $4,000,000; grain and flour, $3,780,000; groceries, $4,000,000; dry goods, $3,380,000; hardware, $1,000,000; liquors, $3,000,000; live stock, $1,414,000; provisions, $2,000,000; manufactures, $5,000,000.

Cotton manufacture is largely increasing. During the present year a very large cotton-factory will commence operations.

The import duties paid at Nashville in 1868 amounted to (coin) $90,000; in 1869, (coin,) $89,000.

I have the honor to be, very respectfully, your obedient servant,

S. T. ABERT,
Civil Engineer, Superintendent Survey Cumberland River.

Major G. WEITZEL,
Corps of Engineers, Louisville, Kentucky.

L 4.

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, January 20, 1871.

GENERAL: By letter from the office of the Chief of Engineers, dated July 23, 1870, I was charged, in addition to other duties, with the survey of the Wabash River, from Wabash, Indiana, to its mouth.

From the amount of money which was allotted to me to conduct the various surveys with which I was charged, I could only set aside $2,000 for this work. No accurate instrumental survey could be attempted with such a small sum, and I therefore determined to limit my operations here to a mere preliminary examination or reconnaisance of the river. Having learned that Mr. F. Stein, of Tipton, Indiana, (a civil engineer of good reputation in the State,) had recently made a map of the State of Indiana, and had many data not in the possession of any one else, I employed him to do the work. His report is herewith transmitted.

The Wabash, with its branches, drains the larger portion of the State of Indiana, a portion of the State of Ohio, and quite a large portion of the State of Illinois. It flows in a southwesterly direction through the northern portion of Indiana, strikes the boundary-line between the two great States of Indiana and Illinois a short distance below Terra Haute, Indiana; then, for nearly two hundred miles of its course, it forms the boundary between these two States, and empties into the Ohio River about one hundred and thirty miles above the mouth of the latter.

It is the most important northern branch of the Ohio River. Below its mouth the Ohio River contains but few obstructions to navigation, and these will probably soon be removed. The three cities, Lafayette, Terre Haute, and Vincennes, are situated on this river.

Twenty years ago the annual value of the commerce of this river and its branches in wheat, corn, pork, and live stock alone, amounted to about $4,000,000; since then, and especially within the last few years, iron and coal veins have been opened.

Now all of this commerce has been nearly entirely ruined by the obstructions in the river. A lock at the Grand Rapids, and a few improvements at other points, were made by private enterprise. But none of these improvements were of a substantial character, and are consequently now in decay.

Now, if this river could be improved only as far up as Lafayette, Indiana, not only would its former commerce return, but it would steadily increase by the development of the mineral resources adjacent to it, and by the continued increase of the population. The soil adjacent to this river is of the most productive kind.

I therefore recommend its improvement as far up as Lafayette. But in order that I can determine exactly how it should be improved, I recommend that the sum of $15,000 be appropriated to make a careful instrumental survey of the river from its mouth to Lafayette, and, as there is no question that the locks at the Grand Rapids should be rebuilt, that the sum of $125,000 be appropriated for that purpose. It will take so much longer to build these properly than it will to improve the various points above and below, and hence by this arrangement no time will be lost.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

TIPTON, INDIANA, *January* 3, 1871.

SIR: In compliance with your orders contained in your letter of the 15th of August, 1870, I have made the preliminary survey and examinations of the Wabash River, from Wabash, Indiana, to its mouth, and have the honor to herewith submit my report.

I began my observations and examinations (wholly superficial, as I had no instruments nor the time sufficient to use them) at the town of Wabash, the proposed head of navigation, and from there went down stream. I found the river between Wabash Town and Logansport running slow on very little descent, in a wide, shallow bed formed of limestone rocks, in a width nearly fourfold that necessary to navigation.

The Erie and Wabash Canal is fed by the river, and dams for that purpose obstruct the river-bed. Besides, there are many bridges spanning the river on a grade entirely too low for the passage of a steamboat, none of which bridges is provided with a draw.

If the Erie and Wabash Canal, which is anything but a paying institution, (it hardly pays the cost of repairs,) was abolished, its waters returned into the river-bed, and the several feeder-dams removed, navigation would be easy up to Wabash Town, at any time from April to December. But if, on the other hand, the water now in the river-bed was by walls confined to about one-third of the present width of the bed, the same could be raised to a height sufficient for light navigation, even in time of drought.

In this latter case, of course, locks would have to be built at each point where there is a feeder-dam in the river.

As the first condition is not likely to occur, and the last is too costly an affair, it must suffice to build locks and clean the river-bed of sand-bars and drift-wood. Such locks will have to be erected at Peru and Logansport at an expense of ($50,000 each) $100,000.

The dredging and clearing the river of drift-wood from Wabash to Logansport will cost about $5,000.

At Logansport the Eel River empties into the Wabash and considerably increases the water of the latter, so that thence downward navigation would be easy, but for the rapids seven miles below Logansport. These rapids will have to be removed at a cost of (7,407 cubic yards, at $2 50 per cubic yard) $18,517 50.

At the mouth of the Eel River is a large deposit of sand and gravel obstructing the river-bed, which to remove would cost (5,555 cubic yards, at 50 cents per cubic yard) $2,777.

About eight miles below Delphi, and about twelve miles above Lafayette, the Tippecanoe River falls into the Wabash. This river is of about twice the size of the Eel River, and from this point down the Wabash is in fact a navigable stream.

Sand-bars and timber buried under the same become frequent here, so much so that it is almost impossible to note and calculate the contents of each one separately. It will have to suffice to mention especially only the larger deposits of sand or gravel, the remainder to be counted by the lump.

Opposite the city of Lafayette is a large sand-bar, to remove which will cost (1,000 feet long, 100 feet wide, and three feet thick—11,000 cubic yards, at 50 cents per cubic yard) $5,500.

A bar of less dimensions is about one mile and a half below Portland, (800 feet long, 75 feet wide, and 3 feet thick,) 2,222 cubic yards, at 50 cents per cubic yard, $3,333.

All the other sand-bars between Logansport and Terre Haute are of such nature that it is impossible to guess even their contents, and can easily be taken out by a steam dredging-machine, probably in two months, at the rate of $28 per day, including hire of machine and hands, $1,400, and would clean the channel from Logansport to Terre Haute after the logs (snags) have been chopped, rolled, and burned, or otherwise put out of the way, at an expense of about $3,500.

There are two dams between Logansport and Lafayette, and consequently two locks will have to be erected on that distance, at $50,000 each, or in the aggregate $100,000. The bridges on this part of the river are higher than those above Logansport, and some have draws.

From Terre Haute downward, the river makes many bends and often very short turns, in which snags and sand-bars have accumulated to such an amount that it will take hundreds of men and horses for months to remove them, and it is pretty well impossible to accurately estimate the cost thereof. I am safe, however, in saying that it will not, on the route from Terre Haute to Vincennes, cost less than $15,000.

Some of the bends in the river below Terre Haute are so narrow that the accumulation of floating timber and of sand is unavoidable, and a "cut-off" in several places is deemed the cheapest, because most lasting improvement. Such a cut-off, for instance, ought to be made at Sugar Creek Bend, in section 32, township 12 north, of range 9 west, immediately south of the city of Terra Haute. The same would cost (175 rods long, 10 feet deep, and $\frac{100+130}{2}$ feet wide=122,964 cubic yards, at 75 cents per cubic yard) $102,223.

A few miles below Sugar Creek Bend is a large deposit of sand known as Musgrove Bar, to remove which will cost (200 yards long, 35 yards wide, and 1 yard deep—7,000 cubic yards, at 50 cents per cubic yard,) $3,500.

About three hundred rods below this bar there is a great deal of drift heaped up, the removal of which, by chopping, rolling, and burning, is included in the above item of $15,000 for men, horses, &c.

Some fourteen miles below Terre Haute is Aurora Bend, about two miles and a half in length, with a ripple about half a mile long, which should be cut off, the course of the water straightened, the fall increased, and the accumulation of drift prevented. This would take (excavation of 825 yards long, $\frac{100+130}{2}$ yards wide, and 3¼ yards deep, =105,302 cubic yards, at 75 cents per cubic yard) $78,621 50.

There are two very narrow bends within five miles of each other in township 8 north, range 11 west, about 120 rods long each. The one known as "Fork's Cut-off" needs only widening of the new channel already in existence; the other, "Hackbury Bend," is full of drift-wood, and will have to be kept clear of it all the time, at an annual expense of hundreds of dollars if it be not cut off, which, together with the widening of the foregoing cut-off, (new channel,) would cost about $100,000.

From here on downward the dredging-machine and axes will find application, the bed being nearly filled with sand and logs.

In sections 6 and 7, township 6 north, range 10 west, the river has formed a new channel, cutting off Horseshoe Bend. This new channel wants widening and clearing of the drift heaped up in it, at an expense of about $35,000.

At Point Coupee, or Oak Station, the river-bed is filled with logs, and thence down stream are many smaller and larger deposits of sand. A little below Vincennes especially, is a large sand-bar, the removal of which will cost $3,500.

Ambrough's Bend, in sections 22 and 23, township 2 north, range 11 west, and about ten miles below, might be cut off, but may do as well if the logs and sand heaped up in the same be removed, and a wing-dam built of the following dimensions: 300 feet long, $\frac{4+12}{2}$ feet wide, and 4 feet high=355 cubic yards, which will cost, at the rate of $2 50 per cubic yard, $887 50. The taking out of the timber and sand at this point will cost about $500.

Within four miles above the mouth of White River the bed of the Wabash is obstructed by what is called the Little Rock, which should be blasted at an expense of about $1,500.

About one mile and a half below the Little Rock begin the Grand Rapids, about three-fourths of a mile long. The rocks forming the rapids cannot be removed without disturbing the proportion of descent of the river, to the great damage of navigation. A lock was therefore built, by means of which boats are raised above the rapids. This lock has a rise of about 12 feet. The same has originally been built, at a cost of $70,000, but was too light for this place, and therefore is now so defective that repairs are attempted in vain, and nothing short of a new lock will remedy the evil. To build a substantial, lasting lock of the proper dimensions, will not cost less than $125,000.

Opposite the mouth of White River is a sand-bar near a mile in length, the removal of which will cost (1,600 yards long, 15 yards wide, and 1 yard thick=24,000 cubic yards, at 50 cents per cubic yard) $12,000.

Six miles below the mouth of White River, at Coffee Islands, I propose a wing-dam to be built, 250 feet long, $\frac{4+12}{2}$ wide, and 4 feet high=296 cubic yards, at $2 50 per cubic yard, $740.

There is good water all along below the mouth of White River, and if the drift-wood and the sand gathered between the same be taken out, there will be no more obstruction to navigation. The taking out of the drift-wood and sand on the distance from New Carmel to Graysville will cost about $3,500.

Opposite Graysville the river makes a deep bend about three miles long, which might be cut off by a new channel of not more than 200 rods in length, the whole cost of which would not exceed $115,000.

Opposite Chainville the bed of the river is obstructed by rocks, which could easily be taken out at an expense of $2,500.

An old wing-dam near this point is entirely broken down, and needs repairing; 250 feet long, $\frac{4+12}{2}$ wide, and 4 feet high=296 cubic yards, at $2 50 per cubic yard, $740.

At this point the river has a strong current to the west. To prevent the destruction of the right bank of the river, and to keep the water in a good channel, a wall of riprap has been built years ago, but it having been erected on a cheap plan, it has not lasted long, and now needs rebuilding. This wall should be 500 rods long, 8 to 10 feet high, 8 feet wide at the base, and 4 feet wide at the top, and will cost (16,500 cubic yards riprap, at $1 50 per cubic yard) $24,750.

About four and a half miles below this point another wing-dam is necessary. It will cost (200 feet long, $\frac{4+12}{2}$ wide, and 4 feet high=274 cubic yards, at $1 50 per cubic yard) $411.

Two miles farther down is "Black's Cut-off," about one mile long, which is now the main channel, the old bed making a large bend westward, being grown up with willows. This new channel at its northern end needs widening and clearing of logs and sand throughout its whole length. This will cost about $3,500.

The last bend the river makes before it empties into the Ohio is a very large one, measuring over seven miles in length, all filled up with sand-bars and drift-wood. This length could be reduced to a mile and a half by cutting a new channel. This new channel would cost (7,900 feet long, $\frac{100+130}{2}$ feet wide, and 10 feet deep=336,481 cubic yards, at 75 cents per cubic yard) $252,360 75.

The dredging of the river from Vincennes to its mouth, by two steam-dredges, will take two months, at $28 each a day, and will cost $1,400.

An accurate survey of the whole river may here and there cause little changes in my estimates, but, on the whole, I think the improvements recommended by me are necessary, and will cost the amounts above stated.

A thorough survey of the river will cost about $15,000, so that the whole improvement of the river, including $25,000 for contingent expenses, will amount to $1,163,253 25.

In this, of course, the value of the lands which will have to be appropriated for the purpose of making the proposed cuts is not included, and I had no time to ascertain the price of lands in that part of the country.

I am, sir, very respectfully, your obedient servant,

FR. STEIN.

Major G. WEITZEL,
Corps of Engineers, Louisville, Kentucky.

L 5.

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, July 31, 1871.

GENERAL: I have the honor to submit herewith my annual report of operations on the survey of the Wabash River, for the fiscal year ending June 30, 1871.

On the 20th of January, 1871, I submitted a special report on this work. On the 14th of April, 1871, I received information that $14,000 had been allotted for its further prosecution. Between these two periods the drawings for the last year's work were completed. The preparations for the field operations were then begun, and the party took the field in May at the mouth of the river, and at the end of the fiscal year had reached Mount Carmel, Illinois.

The field-work of this survey will be completed, and a special report transmitted, in time to be laid before Congress at its next session.

The amounts that have been allotted for this work are as follows:

Allotted under the act of July 11, 1870	$2,000
Allotted under the act of March 3, 1871	14,000
Total	16,000

This will complete the work.

The Wabash River runs through several collection districts, the names of which I could not learn.

The nearest port of entry is Evansville, Indiana. The amount of revenue collected at this port during the fiscal year ending June 30, 1871, was $70,479 99.

The commerce and navigation of the Mississippi River, and all of its tributaries, would be benefited by the improvement of this river.

The amount of cash received for this work during the fiscal year ending June 30, 1871, was $8,000. The amount expended during the same period was $5,174 43.

The amount of appropriation available July 1, 1871, was $8,000. No more money is required for this work.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

L 6.

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, July 31, 1871.

GENERAL: I have the honor to submit herewith my annual report of operations on the survey of the Cumberland River, for the fiscal year ending June 30, 1871.

From the time that my special report on this survey was made (January 20, 1871) until the 14th of April, 1871, nothing was done but to complete the drawings of the survey of last year. I then received notice that $8,000 had been allotted to prosecute the survey, and I accordingly made the preparations to resume the work. The party took the field in June, commencing at the head of navigation, and at the end of the fiscal year had reached Wild Goose Shoals, fifty-three miles below.

A special report of this survey will be submitted in time to be laid before Congress at its next session.

The amounts that have been allotted for this work are as follows:

Allotted under the act of July 11, 1870	$12,198 22
Allotted under the act of March 3, 1871	8,000 00
Total	20,198 22

This will complete the work.

The Cumberland River runs through several collection districts, the number of which I could not obtain.

The nearest port of entry is Louisville, Kentucky.

The amount of revenue collected at this port during the fiscal year ending June 30, 1871, was $131,810 92.

The commerce and navigation of the Mississippi River, and all of its branches, would be benefited by the improvement of this river.

The amount of cash received for this work during the fiscal year ending June 30, 1871, is $12,198 22. The amount expended during the same period, $9,622 44.

The amount of appropriation available July 1, 1871, was $8,000. No more money is required for this work.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

L 7.

UNITED STATES ENGINEER OFFICE,
Louisville, Kentucky, January 20, 1871.

GENERAL: By letter from the office of the Chief of Engineers, dated July 23, 1870, I was charged, in addition to other duties, with the survey of the French Broad River, Tennessee.

For the sake of economy I placed my assistant, First Lieutenant M. B. Adams, Corps of Engineers, (who is in the immediate charge of the Tennessee River improvement,) in the immediate charge of this survey. I have the honor to submit herewith his report. The drawings accompanying his report will be transmitted to-day by express.

The French Broad River is a branch of the Holston River. The latter, with its junction with the Clinch River, form the Tennessee River proper. The latter above Chattanooga is in need of some improvements. Even then, if the commerce of the French Broad River warranted the expense incidental to its improvement, as the report of Lieutenant Adams shows it does not, it would seem to me improper first to improve a branch, where the main river below it is unimproved. I cannot therefore at present recommend an appropriation for the improvement of this river.

I am, sir, very respectfully, your obedient servant,

G. WEITZEL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

CHATTANOOGA, TENNESSEE, *October* 20, 1870.

SIR: I have the honor to submit the following report upon the survey of the French Broad River, made September, 1870, with a view to the improvement of that stream for purposes of steamboat navigation, viz:

Looking at the French Broad River as a stream to be made navigable for steamboats at all seasons of the year, my first inquiry was, how far it had ever been ascended by them under the most favorable circumstances, and to what extent the river traffic made it profitable to run keel-boats above such point. I found that Dandridge, county seat of Jefferson County, ten miles distant from New Market, a place on the East Tennessee and Virginia Railroad, was the highest point to which steamboats had ascended, and that the traffic of the river above there was such as to only justify the running of a single keel-boat, capable of carrying about twenty-five tons. I therefore concluded to make Dandridge a fitting-out and starting point in the survey of the river. I concluded to purchase there a boat that would carry our instruments and luggage, and to drop down on this, taking soundings in the channel along the way wherever a place was met with in the channel that at low water would be less than the minimum for steamboats, to cast anchor and examine minutely, thus confining my attention to where actual improvement was necessary. In addition to this, I thought to make a cursory examination of the obstructions that made Dandridge the head of navigation; that would be as extended a survey as the appropriation of $1,000 would permit me to make.

The geographical situation of the French Broad River, between the Bays and Smoky Mountains, together with the fact that there is no railroad in its valley till a point is reached twenty-two miles above the head of navigation, and eighty-three miles above the mouth of the stream, makes it seem particularly desirable that the river should be opened to that point where the C., C. G. & C. R. R., enters its valley, especially as the transportation has now principally to be done by wagoning, ten miles or more over the Bays Mountains, to some point on the East Tennessee and Virginia Railroad, where a market is found for the products of corn, bacon, &c., of the French Broad Valley.

1. FRENCH BROAD RIVER ABOVE DANDRIDGE.

My reconnaissance of the French Broad River, above Dandridge, commenced at a point two miles by land and ten miles by water, below the mouth of Nolichucky River, at which point there is a railroad station called Leadvale, and the C., C. G. & C. R. R. crosses the French Broad River. I am told that there is good navigable water from the mouth of the Nolichucky to Leadvale, though I am inclined to believe that not more than 2 or 2½ feet would be found in some portions of the ten miles of river intervening, if soundings were taken.

First obstruction.—The first obstruction below Leadvale is known as Franklin-Ford Shoals, (one and a fourth miles below Leadvale.)—This obstruction consists of a gravel bar extending across, and measuring 300 feet in the direction of the channel. Our soundings over this bar gave but 18 inches of water, and the river stage was assumed to be 6 *inches above low water* I would here state that there was very little, indeed no change, in the stage of the river during the time that we were making the survey.

Second obstruction.—Ten Island Shoals, (two miles below Leadvale.)—Considerable work has been done at this point in the way of improvement; riprap dams have been put in, connecting island with island, thus confining the water to a narrow channel near the left bank of the river. The current, however, is very swift, with a fall of 5 feet in three-fourths of a mile through this channel, and the dams have given way in some places. It is estimated that 500 cubic yards of stone will be required to make these dams again effective.

Third obstruction.—Dan Allen's Mill Shoals, (five miles below Leadvale.)—At this point a mill-dam has been constructed, which most completely obstructs the channel of the river, extending, as it does, two-thirds way across. Another feature of the obstruction, however, is the fall of 10 feet in one mile in length of the river; this, together with the increased width, which is ordinarily from 400 to 500 feet, but is here at least 800 feet wide, reduces the depth of the water to only 12 inches for about a half mile below the dam.

Fourth obstruction.—Taylor's Shoals, (eight miles below Leadvale.)—The river here again widens to twice its usual width. The water of the river which, between obstructions named, is of gentle current, and good navigable water of from 4 to 8 feet in depth, now reduces to 2 feet for 750 feet, measured in the direction of the channel.

Fifth obstruction.—Taylor's Fish-trap Dam, (eight and one-third miles below Leadvale.)—Here another shoal place was met with, and for 800 feet only 2 feet of water was found in the channel. The current too was about three and one-half miles per hour, and the fall in this 800 feet was thought to be not less than 3 feet.

Sixth obstruction.—Rock Reef, (eight and two-third miles below Leadvale.)—This is a solid rock reef, extending across the entire river and measuring about 50 feet in the direction of the channel, over which our soundings returned us but 2 feet of water.

Seventh obstruction.—Evans's Fish-trap Dam, (eleven miles below Leadvale.)—The river at this point is about 700 feet wide, which, together with an increased fall, has caused a shoaling for 150 feet below the fish-trap. Our soundings returned us 2 feet of water over this 150 feet, when we again got from 4 to 6 feet of water. The change usually occurred very suddenly, passing from 2 feet to 4 or 5 feet.

Eighth obstruction—Old Government Dams, (thirteen miles below Leadvale.)—There has been an effort made to improve the river channel at this point by the construction of two wing-dams, one 1,000 feet long and the other about 400 feet long. The dams have not been built to a sufficient height, however, to make the improvement entirely effective. Between the dams, for 200 feet, only 2-feet soundings were found, though parallel and close to the dams the depth was a little greater.

Ninth obstruction—Swan's Island Shoals, (twenty miles below Leadvale.)—This obstruction is much like the first named, consisting of a gravel bar, which extends across the entire river and measures some 200 feet in the direction of the channel, over which only 2 feet of water was returned to our soundings. This, like the first obstruction named, is used as a ford in crossing the river, the bottom being of a solid hard gravel.

From a brief *résumé* of the foregoing, it will be seen that there are no less than nine obstructions between Leadvale and Dandridge; that these are almost all due to the same cause, viz: a sudden fall in the river bed, together with a widening of its banks, and at such places only 12 or 18 inches of water will be found at extreme low water. Between such obstructions there is found good navigable water of from 4 to 8 feet in depth, with gentle current. However, there are nine obstructions in twenty miles of river, almost one to every two miles, each of which will require a great outlay of money to make them passable for steamboats. I cannot, therefore, but consider it as injudicious on the part of the Government to again improve this river, unless, indeed, she is willing to anticipate the wants of the people some years ahead. The mere fact that one keel-boat does all the traffic for the French Broad River above Dandridge, and for miles below, speaks louder than anything else to tell the story of their wants.

The country adjacent to the French Broad River, between Leadvale and Dandridge, is all good farming land. Besides there are two gaps, Irish and Dutch Gaps, as they are called, in this portion of the river, where the hills fall away from the river bank on the left, and the bottom land extends back a mile or more from the river. Each of the gaps measures at least a mile along the bank of the river, and this bottom land, which usually does not extend to more than one-eighth or one-quarter of a mile from the river, is considered much more fertile, and therefore more valuable than the uplands.

2. THE FRENCH BROAD RIVER BELOW DANDRIDGE.

In making the survey of the French Broad River, from Dandridge to its mouth, my attention, as before stated, was principally given to those portions where improvement is absolutely necessary to the stream's being made navigable for steamboats. At all such obstructions I took the falls from their upper to the lowermost point; at the same time took the soundings through the channels, (or chutes,) where there were more than one, and I submit herewith maps of each of such obstructions met with below Dandridge. These will give at once an idea of the nature of the obstructions, though the three most prominent, viz: Fain's Island, Evans's Island, and Seven Island Shoals, should, I think, receive some detailed explanation. The other obstructions are of minor importance, and the maps, with the notes thereon, will, I believe, convey a sufficiently clear idea of the nature of each of them.

Fain's Island Shoals, (one mile below Dandridge.)—As will be seen on the maps the river divides here into two main channels; the left is more contracted throughout its entire length, and measures about three miles from its head to the point of uniting with the right channel at the foot of Fain's Island; whereas the right channel measures only about two miles, taken along its own course between the same points; besides its banks are wider throughout.

The more direct and wider channel was the one selected for improvement some years ago—I am told in 1846; and, as indicated on the map, this improvement was thought to be effected by a number of wing-dams, the evident object of which was to contract the channel at each of the places of sudden fall or shoaling from any other cause.

It is most interesting to observe now the effects of these dams, especially of the one at the head of the island, almost a quarter of a century after they were built.

The dam at the head of Fain's Island was constructed with the apparent object of throwing nearly all the water of the river into the right chute, built, as it is, from a point within 40 feet of the left bank, just above the left chute, across the head of that chute, and extending to a point near the right bank of the right chute. (See map.) Now, the effect of this dam has been to fill in with gravel and sand all above and to the right of it, except a narrow sluice, close in to the left bank, through which 8 feet of water is found, down past the head of the dam, and so on, for some distance down the left chute. Again, this filling in to the right of the dam, which shoaling extends entirely across the head of the right chute, has so dammed the water that not more than half of the same passes to the right of the island. Now, in addition to this, it will be seen that the soundings give better water throughout the left chute; therefore, if any improvement is deemed advisable, I would recommend the completion of this damming-up, and the use of the left chute for purposes of navigation, instead of milling purposes, for which it is now used, particularly as there are *three miles* in which to *overcome* the *fall* of 10.2 *feet*, from the head to the foot of Fain's Island, in place of only *two miles* as in the *right chute*.

Evans's Island Shoals, (ten miles below Dandridge.)—At the head of this obstruction, (see map,) the river divides into no less than five separate chutes; only two of these, however, extend to any great distance down the river. The right-middle and left-middle chutes, are the ones used by the ascending or descending keel-boat; of these the right-middle chute offers advantages over the other for improvement. Near the head of the right-middle chute, there is a sudden fall of over 2 feet, though this is more due to the banking up of the water by a fish-trap dam, and then its being allowed to drop through a narrow sluice into the lower level, than to any increased dip in the bed of the river. The depth of water from the foot of this fall to the lower end of Evans's Island varies from 2½ to 4 feet, and the current is uniformly gentle. At the foot of Evans's Island there is another difficulty encountered. The Government built a dam at this point, which reaches from about midway of the right chute to a point below and nearer the left bank of the river; the apparent object of this dam was to increase the depth of water to its left; there was space enough, however, left between the dam and the right bank for considerable water to pass, and this being taken advantage of for milling purposes, there was a section added to the head of the Government dam, that reaches nearly to the foot of Evans's Island, and a mill-dam was built from the foot of the Government dam to the right bank—thus, it will be seen, vitiating the object of the Government dam, if not absolutely monopolizing the best water of the river.

As an improvement for this entire obstruction I would recommend the damming of the left and left-middle chute, by a dam connecting the heads of the little islands with Evans's Island; the removal of the fish-trap dam near the head of the right-middle chute; the completion of the damming in of the right chute at the foot of Evans's Island by continuing the dam there to the foot of that island; and the removal of the mill-dam that has been placed at the foot of the Government structure there.

Seven-Island Shoals, (thirty miles below Dandridge.)—This is perhaps the greatest obstruction on the French Broad River, being made up of almost continuous shoal water for over two miles, and a succession of rapids, with an entire fall of 10¼ feet in about a mile and a half. Besides, there is an abrupt turn in the main channel, to the right of Round Island, near the lower end of this obstruction, which is considered, even by the raftsmen on the river, as very difficult to make. Indeed, I look upon Seven-Island Shoals as the obstruction on the French Broad River owing to which, probably, there has been little or no steamboat traffic on this stream at any season of the year. But, were this remedied, there would still remain the Gallops, Hanging Rock, Bryant's Shoals, and Siph's Shoals, all obstacles of considerable magnitude to be overcome, to enable a boat to ascend to the foot of Evans's Island Shoals, twenty miles above. There are, therefore, five obstructions in twenty miles of river, and though there is some lumbering done on the river just above Seven-Island Shoals, (one saw-mill,) I question whether it would be exactly economy on the part of the General Government to expend at this point $40,000 for its improvement.

I estimate roughly, though I am prepared to give a detailed estimate, that it will cost not less than $150,000 to make the French Broad River navigable from Dandridge to its mouth.

I am, sir, very respectfully, your obedient servant,

M. B. ADAMS,
First Lieutenant, Corps of Engineers.

Major G. WEITZEL,
Corps of Engineers, Louisville, Kentucky.

APPENDIX M.

PAINESVILLE, OHIO, *September* 28, 1871.

GENERAL: I have the honor to submit below my annual report for the fiscal year ending June 30, 1871, relating to the public works under my charge at that date.

IMPROVEMENT OF THE TENNESSEE RIVER.

Under charge of Major G. Weitzel, Corps of Engineers, until May 24, 1871; since then under charge of Major Walter McFarland, Corps of Engineers.

The unexpended balances of the appropriations for the improvement of this river, which, under a previous act of Congress, were to revert to the Treasury of the United States, were by the second section of the act of March 3, 1871, relating to rivers and harbors, re-appropriated, to be applied, as the Secretary of War might direct, to the repair of the works of improvement previously begun between Knoxville and Chattanooga, to the improvement of the Tennessee below Chattanooga, and of Muscle Shoals.

Under this ordering, $35,000 were set aside for the improvement of the river between Knoxville and Chattanooga; and the balance was to be applied to the various works of improvement which had been ordered to be undertaken below Chattanooga.

None of this money was to be expended upon Muscle Shoals as a special allotment from the general appropriation, for surveys had been made for the re-survey of the Tennessee River from Brown's Ferry, Alabama, to Florence, Alabama, with a view to its improvement, which part of the river included the Muscle Shoals.

The amount available then for the improvement of the Tennessee, after the passage of this act, was as follows, viz:

Balance on hand June 30, 1870	$32, 330 91
Undrawn from the Treasury	110, 095 00
Total available	142, 425 91

During the year there were drawn from the Treasury		$50,000 00
Which, added to the balance		32,330 91
On hand June 30, 1870, amounted to		82,330 91
Of this amount there have been expended—		
At the Suck	$12,612 19	
At the Pot	4,500 00	
At Colbert Shoals	15,412 87	
At Bee-Nee Shoals	3,721 12	
For contingencies	6,006 93	
Due retained percentage	11,537 96	
		53,791 07
On hand June 30, 1871		28,539 84
Remaining in Treasury		60,095 00
Total available		88,634 84

Of which $35,000, still in the Treasury, are to be applied to the improvement of the Tennessee River above Chattanooga, and the balance is to be applied to the improvement of the Tennessee below that point.

The work done during the year at the various points in relation to which contracts had been entered into is as follows, taking them in order from Chattanooga downward, viz:

Ross's Tow-head.—Nothing.

Tumbling Shoals.—Nothing.

The Suck.—About 4,000 cubic yards of rock, boulders, and gravel have been removed, which nearly completes the work ordered at this point, but a few hundred cubic yards remaining to be removed.

The Pot.—The improvement here is virtually completed so far as ordered, but three or four hundred yards of gravel remaining to be removed. Boatmen state that this has ceased to be an obstacle, and that its passage may now be effected safely in a canoe where it was formerly difficult and dangerous for large boats.

Colbert Shoals.—About 500 cubic yards of rock have been removed from Hoop-pole Reef, and nearly 10,000 cubic yards of rock have been formed into riprap dams, between Tow-head No. 1 and the left bank, and at the foot of Colbert Island, leaving about 5,000 cubic yards yet to be added to them. The contractor has been unfortunate here in being compelled to remove a portion of a bracket-dam which he had constructed in the channel in order to secure quiet water for his work below it, and which has become so much of an obstacle to the passage of steamboats and barges as to occasion great complaint.

Bee-Nee Shoals.—Two thousand cubic yards of stone have been formed into a riprap dam here, which nearly completes it. About 700 cubic yards of rock are still to be excavated from the bed of the channel here.

These are the only points on the river at which when the fiscal year began work remained to be done under existing contracts. These contracts are held by one man, Mr. J. H. Dennis, of Louisville, Kentucky, and for some reason he has not progressed with them as rapidly as was expected at the date of the last annual report upon these improvements. One of his contracts was entered into in 1868; the other in 1870. The period for completing his work has been extended at three different times by authority of the Chief of Engineers, and now extends to December 31, 1871. It is hoped that all that he has contracted to do will be finished by that date.

Until the effects of the improvements now being made in this part of the river are observed, it is not deemed necessary to ask for any further appropriation for them.

An examination of the Tennessee River between Chattanooga and Kingston, with a view to its improvement, was made in the spring of the year, under orders from Major G. Weitzel, who presented a scheme for the application of the $35,000 which had been allotted to this part of the river. This scheme, which, upon my assuming charge of the improvement of the Tennessee, had been referred to me, was concurred in by me, approved by the Chief of Engineers, and in July I was authorized to advertise for proposals accordingly. Since the close of the fiscal year this has been done, but owing to the unreasonable character of the bids received, they were all rejected, and the work re-advertised under instructions from the Chief of Engineers; no work, of course, has been done upon it.

As it is quite certain that the total cost of completing the improvements as designed will exceed the amount now available, an additional appropriation of $25,000 is asked for this purpose.

The only contracts formed during the year were entered into with Mr. J. H. Dennis, of Louisville, Kentucky, for certain works at Ross's Towhead, the Pot, Colbert Shoals, and Bee-tree Shoals, under the appropriation of $80,000 for the improvement of the Tennessee River below Chattanooga, made in 1870, only $45,000 of which was ordered to be expended below Chattanooga, the remainder, $35,000, being reserved until authority could be obtained to apply it to the improvement of the Tennessee *above* Chattanooga, where it was much needed; which authority was obtained by act of Congress, approved March 3, 1871, making appropriation for certain river and harbor improvements, surveys, &c.

An abstract of all bids received under the advertisement calling for proposals, and an abstract of contracts formed accordingly, accompany this report.

No allusion is here made to the cost of opening the Muscle Shoals to navigation, inasmuch as that is a matter which has been made the subject of a special survey, and upon which a special report must be made.

Until the Muscle Shoals are opened, the amount of commerce benefited by the improvement of the Tennessee River above that obstruction cannot be considered very great, as there is not trade enough to keep more than half a dozen steamers of small capacity employed, with their accompanying flat-boats, carrying the products of the farms, iron-works, and coal mines along the line of the river to Knoxville, Kingston, Chattanooga, and Decatur, and carrying back necessary groceries, hardware, &c., the whole distance being about three hundred and thirty miles by river. A much larger trade, however, is affected by the improvements below Florence, which has direct communication by water and a large commerce in cotton with Cincinnati and other points on the Mississippi and the Ohio.

The opening of Muscle Shoals to navigation would, however, convert the commerce of the Upper Tennessee from its present local character into something more of a national character, by giving it cheap and easy communication with the great centers of trade in the West, Northwest, and South, and would, unquestionably, exert a powerful influence in developing the wonderful mineral resources of this almost isolated region of Eastern Tennessee and Northern Georgia and Alabama.

The nearest port of entry is Louisville, Kentucky. I am unable to state the amount of its revenue from customs, no answer having been received by me from the collector to whom I addressed the inquiry.

SURVEYS.

The following-named surveys which have been placed in my charge have not been completed so as to enable me to report fully upon them now, and will require an additional report from me when finished, viz:

1. Survey of Tennessee River from Brown's Ferry, Alabama, to Florence, Alabama.
2. Survey and examination of the Coosa, Etowah, and Oastenaula Rivers.
3. Canal survey from the Tennessee to the Coosa.
4. Canal survey from the Etowah to the Oemulgee.

Progress has been made in all of these, excepting the last, and the surveys of the Tennessee, from Brown's Ferry, Alabama, to Florence, Alabama, and of the Coosa, from Wetumpka, Alabama, to the crossing of the Selma, Rome, and Dalton Railroad, have been completed.

The map and report of the former are under way.

The map of the latter is completed, though the report which should accompany it is not ready, owing to the accidental drowning of the civil assistant engaged upon it, Mr. Henry C. Fillebrown, civil engineer.

The canal survey from the Tennessee to the Coosa is being now run, and that from the Etowah to the Ocmulgee will shortly be begun.

It is expected that all these surveys will be completed and reported upon by the middle or end of December next.

RECAPITULATION.

The improvements ordered at the Suck and at the Pot have been successfully accomplished. Those at Colbert Shoals and Bee-Nee Shoals are well advanced. Those at Ross's Tow-head and at Tumbling Shoals are not yet begun. It is expected that all will be completed by the end of December.

Proposals for improving the Tennessee, above Chattanooga, have been called for by public advertisement.

Balance on hand June 30, 1870	$32,330 91
Received from Treasury	50,000 00
	82,330 91
Expended and due	53,791 07
Balance June 30, 1871	28,539 84
Remaining in Treasury	60,095 00
Still required for application to the improvements of the Tennessee, above Chattanooga	25,000 00

Survey of Tennessee River from Brown's Ferry to Florence, and of Coosa from Wetumpka to railroad bridge, completed, except as to office-work.

Other surveys favorably progressing and to be completed and reported upon by end of December, 1871.

Respectfully submitted.

WALTER McFARLAND,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tennessee, October 9, 1871.

GENERAL: I have the honor to transmit herewith an abstract of the bids received, and to-day opened, in accordance with advertisement from this office, dated August 30, 1871, and relating to the improvement of the Upper Tennessee, a copy of which was sent you under date of September 9. It will be observed that but two of the number are formal, and of these, that made by Albert Blaisdell, of Haverhill, Massachusetts, is the most favorable, and is reasonable. I therefore recommend that the contract for doing the work under his bid be awarded to him.

Very respectfully, your obedient servant,

WALTER McFARLAND,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

Abstract of bids received at Louisville, Kentucky, September 24, 1870, *in response to advertisement dated Louisville, Kentucky, July* 24, 1870, *calling for proposals for improving the Tennessee River, below Chattanooga, Tennessee.*

No. 1.—Bidder: O. J. Jennings, Syracuse, Onondaga County, New York. Guarantors: C. J. De Graw and D. E. Fay, Fulton, Oswego County, New York. Certified by James D. Lusher, assistant assessor 3d division of 22d district, New York.

	Rock excavation.	Boulder excavation.	Gravel excavation.	Riprap dam construction.	Building capstan.	Total for each point.
Ross's Tow-head:						
Quantity in cubic yards.	750			750		
Price	$7 00			$2 00		
Amount	$5, 250 00			$1, 500 00		$6, 750 00
Suck:						
Quantity in cubic yards.		2, 500				
Price	$8 00	$3 00				
Amount		$7, 500 00				7, 500 00
Pot:						
Quantity in cubic yards.	3, 000					
Price	$4 50					
Amount	$13, 500 00					13, 500 00
Skillet:						
Quantity in cubic yards.	5, 000					
Price	$8 00	$8 00		$3 00		
Amount	$40, 000 00				$700 00	40, 700 00
Widow's Bar:						
Quantity in cubic yards.				1, 350		
Price	$8 00			$3 50		
Amount				$4, 725 00		4, 725 00
Belfont Shoals:						
Quantity in cubic yards				1, 350		
Price	$9 00		$1 00	$3 50		
Amount				$4, 725 00		4, 725 00
Large Rocks:						
Quantity in cubic yards.	5					
Price	$9 00	$8 50		$3 00		
Amount	$45 00					45 00
Gunter's Reef:						
Quantity in cubic yards	300					
Price	$9 00					
Amount	$2, 700 00					2, 700 00
Gunter's Shoals:						
Quantity in cubic yards.	75					
Price	$9 00					
Amount	$675 00					675 00
Limestone Bar:						
Quantity in cubic yards.						
Price	$8 00					
Amount						
Colbert Shoals:						
Quantity in cubic yards	2, 000			3, 490		
Price	$8 50	$9 00		$3 50		
Amount	$17, 000 00			$12, 215 00		29, 215 00
Bee-tree Shoals:						
Quantity in cubic yards.	2, 933	100		4, 500		
Price	$9 00	$9 00		$3 00		
Amount	$26, 397 00	$900 00		$13, 500 00		40, 797 00
Total of bid						151, 332 00

Abstract of bids received at Louisville, Kentucky, September 24, 1870, &c.—**Continued.**

No. 2.—Bidder: J. H. Dennis, Louisville, Kentucky. Guarantors: Isham Henderson and E. Graves, Louisville, Kentucky. Certified by I. L. Divine.

		Rock excavation.	Boulder excavation.	Gravel excavation.	Riprap dam construction.	Total for each point.
Ross's Tow-head:						
Quantity in cubic yards		750			750	
Price		$4 00			$2 25	
Amount		$3,000 00			$1,687 50	$4,687 50
Suck:						
Quantity in cubic yards			2,500			
Price			$1 50			
Amount			$3,750 00			3,750 00
Pot:						
Quantity in cubic yards		3,000				
Price		$1 50				
Amount		$4,500 00				4,500 00
Skillet:						
Quantity in cubic yards		5,000				
Price		$1 87				
Amount		$9,350 00				9,350 00
Widow's Bar:						
Quantity in cubic yards					1,350	
Price					$2 75	
Amount					$3,712 50	3,712 50
Belfont Shoals:						
Quantity in cubic yards					1,350	
Price					$2 25	
Amount					$3,037 50	3,037 50
Large Rocks:						
Quantity in cubic yards	15					
Price	$10 00					
Amount	$150 00					150 00
Gunter's Reef:						
Quantity in cubic yards	300					
Price	$5 00					
Amount	$1,500 00					1,500 00
Gunter's Shoals:						
Quantity in cubic yards	75					
Price	$7 00					
Amount	$525 00					525 00
Limestone Bar:						
Quantity in cubic yards					3,600	
Price					$2 50	
Amount					$9,000 00	9,000 00
Colbert Shoals:						
Quantity in cubic yards	2,000				3,490	
Price	$3 75				$2 25	
Amount	$7,500 00				$7,852 50	15,352 50
Bee-tree Shoals:						
Quantity in cubic yards	2,933	100			4,500	
Price	$3 75	$3 75			$2 25	
Amount	$10,998 75	$375 00			$10,125 00	21,498 75
Total of bid						77,063 75

Abstract of bids received at Louisville, Kentucky, September 24, 1870, *&c.*—Continued.

No. 3.—Bidder: J. J. Hinds, Decatur, Morgan County, Alabama. Guarantors: D. C. Whitney and J. M. Hinds, Decatur, Morgan County, Alabama. Certified by George E. Spencer.

		Rock excavation.	Boulder excavation.	Gravel excavation.	Riprap dam construction.	Total for each point.
Ross's Tow-head:						
Quantity in cubic yards		750			750	
Price		$3 00			$3 00	
Amount		$2, 250 00			$2, 250 00	$4, 500 00
Suck:						
Quantity in cubic yards			2, 500			
Price			$3 00			
Amount			$7, 500 00			7, 500 00
Pot:						
Quantity in cubic yards		3, 000				
Price		$3 00		$1 00		
Amount		$9, 000 00				9, 000 00
Skillet:						
Quantity in cubic yards						
Price						
Amount						
Widow's Bar:						
Quantity in cubic yards					1, 350	
Price					$4 00	
Amount					$5, 400 00	5, 400 00
Belfont Shoals:						
Quantity in cubic yards					1, 350	
Price					$4 00	
Amount					$5, 400 00	5, 400 00
Large Rocks:						
Quantity in cubic yards	5					
Price	$5 00					
Amount	$25 00					25 00
Gunter's Reef:						
Quantity in cubic yards	300			300		
Price	$3 00			$1 00		
Amount	$900 00			$300 00		1, 200 00
Gunter's Shoals:						
Quantity in cubic yards	75			75		
Price	$3 00			$1 00		
Amount	$225 00			$75 00		300 00
Limestone Bar:						
Quantity in cubic yards					3, 600	
Price					$3 00	
Amount					$10, 800 00	10, 800 00
Colbert Shoals:						
Quantity in cubic yards	2, 000				3, 490	
Price	$4 00				$3 25	
Amount	$8, 000 00				$11, 342 50	19, 342 50
Bee-tree Shoals:						
Quantity in cubic yards	2, 933			100		
Price	$4 00			$1 00		
Amount	$11, 732 00			$100 00		11, 832 00
Total of bid						75, 299 50

Respectfully submitted.

G. WEITZEL
Major of Engineers.

Abstract of contracts between Major G. Weitzel, Corps of Engineers, on behalf of the United States, and J. H. Dennis, for the improvement of the Tennessee River at certain points.

Number.	Name of contractor.	Residence of contractor.	Names of bondmen.	Amount of bond.	Date of contract.	Points for work under the contract.	Rock excavation, per cubic yard.	Riprap, per cubic yard.
1	J. H. Dennis.	Louisville, Ky.	Isham Henderson	$50, 000	Oct. 20, 1870	Ross Tow-head	$4 00	$2 25
			J. D. Osborne.			The Pot	1 50	......
						Colbert Shoals	3 75	2 25
						Bee-Tree Shoals	3 75	......
2	*J. H. Dennis.	Louisville, Ky.	....	....	Feb. 1, 1871	Bee-Tree Shoals	......	2 25

* Supplementary contract.

Respectfully submitted.

G. WEITZEL,
Major of Engineers.

M 1.

UNITED STATES ENGINEER OFFICE,
Chattanooga, Tennessee, August 9, 1871.

MAJOR: In compliance with verbal instructions, and in reply to Department letter of the 14th ultimo, approving of the application of $35,000 for the improvement of the Tennessee River above Chattanooga, and suggesting that a report of the project in detail be submitted, I have the honor to submit the following:

GENERAL CHARACTER OF OBSTRUCTIONS.

The obstructions to navigation above Chattanooga, like the majority of those below, are "low-water obstructions," and consist of bars, either rock or gravel, extending across the river, with a length varying from 60 feet to two miles; the depth of water over these bars varying from 10 inches to 30 inches, at extreme low water; and the current varying from three to six miles per hour.

Between these bars the stream is deep and the current less swift, and the river is thus divided into pools and chutes. The general nature of the rock-bed is limestone, at some points largely interpersed with flints.

Across these bars the water has, in many instances, cut for itself, at low water, a channel-way, always crooked, generally narrow, and with isolated rocks or loose boulders obstructing them, thus rendering the navigation of these passages both difficult and dangerous.

FORMER IMPROVEMENTS.

Attempts to improve the navigation have already been made at some of the obstructions. The first, in 1832, by Colonel Long; the second, in 1856, by Colonel J. McClellan. The method employed in both instances was the construction of "wing-dams," for the purpose of contracting the water-way at low water, with a view of deepening the water on the shoals. Time and experience have shown that the work done at those periods was inadequate, if not, to a certain extent, incorrect. The following are the defects as now seen:

1. Cross-section of the dam too small.

2. Fragments of stone used in their construction so small and light as to be carried away by the force of the current and the action of drift.

3. The timber employed in their construction being exposed to the influence of wet and dry rot, has been dislodged or carried away, to the great destruction of the dam.

4. In many cases the axis of the dam makes too great an angle with the axis of the current, thus tending to pile the water up suddenly along the entire face of the dam; instead of deflecting the water, and causing it to accumulate on or above the obstruction, to expose the crest of the dam to greater abrasion and prevent the deposition of sediment; all of which ill effects would be, to a great extent, avoided by dams making small angles with the axis of the current.

5. The junction of the dams with the shore insecurely established, thus enabling the water to seek a passage between the end of the dam and shore, and thereby destroying, in a measure, the efficacy of the dam.

As a result of the above defects, but little benefit is now obtained at the points where work has been done.

PROPOSED GENERAL PLAN OF IMPROVEMENT.

In view of the above facts, and of the small amount to be expended in comparison with the obstructions, the following general plan of improvement is proposed:

Removal of a small amount of solid rock from the natural channel.

Removal of isolated rocks and boulders from the natural channel.

Removal of gravel, sand, and snags from certain bars.

Construction of riprap dams to contract the water-way, all at such points as shall best improve the navigation, and give at extreme low water a channel-way over these obstructions at least 3 feet deep and 140 feet wide.

POINTS FOR IMPROVEMENT, WITH DETAILS OF PLAN.

1. *Sandy Creek Shoals,*

the first important obstruction above Chattanooga, situated about thirty-five miles above Chattanooga.

The obstruction consists of a rock-bar, a gravel-bar, and a rock-reef, the passage through which is much obstructed, at low water, by detached rocks. Over the rock-bar there is at low water but 20 inches of water; over the gravel-bar, but 15 inches; the detached rocks in the passage are exposed to view at extreme low water.

Former improvements consisted of a dam extending from the head of Tow-head to left bank, angle being about 70°, for the purpose of accumulating all the water, at low water, on the right chute or channel (the river being divided by the Tow-head and island below) of a dam connecting the Tow-head and island, and of a long dam at the foot of the island to confine the water and carry over the rock-ledge below. The dam at the head of the Tow-head has been so abraded as to be of little or no use; the connection between this dam and the left bank has been destroyed, so that there is now a channel for steamboats between the head of the Tow-head dam and bank, the same between the end of the Tow-head dam and the island, while the dam at the foot of the island is also much broken, owing to decay of timbers.

It is proposed to construct a new dam at the head of the Towhead, diminishing the angle to 45°, and extending two-thirds of the way across the river, to remove a portion of the old dam near left bank, to repair and enlarge the other dams, to excavate from the gravel-bar, and to remove the detached rock and boulders from the passage through the rock-ledge.

Estimated quantities to accomplish the above improvement.—Removal of 300 cubic yards of rock; removal of 100 cubic yards of gravel, &c.; removal of 10 snags from channel-way; construction of 1,800 cubic yards of riprap dam.

2. *Kelley's Shoals,*

the next obstruction of importance after passing Sandy Creek, being about sixty miles above Chattanooga. The obstruction consists of a long rock-bar, extending about three-fourths of a mile down stream, there being only an average depth of 18 inches, at extreme low water. A channel-way, tortuous and narrow, with projecting rocks, exists across the ledge, and through which the pilots find a way.

Former improvements—none attempted.

It is proposed to widen and straighten the existing channel by the excavation of the rock-bed, and to remove the loose rock, &c., which now obstructs the passage.

Estimated quantities to accomplish the above improvement.—Removal of 900 cubic yards of solid rock; removal of 100 cubic yards of loose rocks and boulders.

3. *Watt's Bar,*

situated about eighty-five miles above Chattanooga. The obstruction consists of a rock-reef only sixty feet long, (in the direction of the current,) which extends across the river, and over which, at low water, there is but 16 inches of water. A crooked narrow passage exists through the reef, obstructed near the end by detached rock.

Former improvements—none attempted.

It is proposed to widen the existing channel by excavating from the rock-bed, and to remove the detached rocks from the channel-way.

Estimated quantities to accomplish the above improvement.—Removal of 200 cubic yards of solid rock; removal of 50 cubic yards of loose rock.

4. *White's Creek Shoals,*

situated about ninety miles above Chattanooga. The obstructions consist of a gravel-bar and three rock-reefs; crossing the left chute, the one used by steamboats, over the bar and reefs, there is not 17 inches of water at extreme low water.

Former improvements consist of a dam extending from the head of "towhead" toward the right bank, angle being about 50°, for the purpose of accumulating water on the gravel-bar and cutting it out. A second dam connects the "towhead" and head of island, to confine the accumulated water in the left chute, and thus "carry the water," as it were, over the rock-reef in the chute. The dam at the head of the "towhead" has been so abraded as to be of no use, or of very little use; the connection between the dam at foot of the "towhead" and the island has been destroyed; so that there is now a wide channel way existing through which a large portion of the water from the left chute flows. This break is so large and deep that steamboats can and do use it as a channel-way, and thus avoid the reefs below.

It is proposed to enlarge, repair, and strengthen the existing dams, close all breaks or connections, and to excavate from the gravel-bar and from the reefs a small portion, and to remove any loose boulders that interrupt the channel-way; also to remove some troublesome snags.

Estimated quantities to accomplish the above improvement.—Removal of 200 cubic yards of solid rock; removal of 100 cubic yards of loose rock; removal of 400 cubic yards of gravel, &c.; construction of 1,800 cubic yards of riprap dam.

5. *Half-Moon Shoals,*

situated about ninety-two miles above Chattanooga. The obstructions consist of a rock bar extending some three miles down the river, of loose boulders and detached rock in the channel way, and of a rock ledge at the foot of Half-Moon Island. Over the rock bar there is but 16 inches of water at low water; over the rock ledge but 10 inches, save through the passage-way which exists here as at other ledges.

Former improvements consist of a dam from head of Island No. 1 toward right bank, angle being 70°. Dam between Island No. 1 and Island No. 2; and a third dam between Island No. 2 and Half-Moon Island, all constructed for the purpose of accumulating and confining the main body of the river (at low-water) to the left chute, the narrowest and longest, and, therefore, the best for an improved channel.

These dams, like all other dams built at the same time, are comparatively useless now. The dam across the river from head of Island No. 1 makes too great an angle with the axis of the stream. It is also so much reduced by abrasion and decay as to allow the water at low-water stages to flow over it. The connection with the shore and island head are also destroyed, allowing the water to flow through. The dams between the island are also destroyed, and the water finds a way both over and around them, owing to the connection between the dam and island being destroyed.

It is proposed to construct a new dam from the head of Island No. 1 toward the right bank, giving the dam an angle of 45°; to repair, enlarge, and strengthen the other dams, and secure their connections with the islands; to excavate some gravel and snags which impede the channel-way; to excavate a channel through the rock-ledge at the foot of the island, and to remove some boulders from the existing channel.

Estimate of quantities necessary for the improvement.—Removal of 500 cubic yards of solid rock; removal of 100 cubic yards of loose rock; removal of 200 cubic yards of gravel; removal of 20 snags; construction of 2,100 cubic yards of riprap dam.

6. *Shield's Dam,*

situated about one hundred and fifteen miles above Chattanooga. The obstruction consists of rock-bar extending across the river; length about 100 feet. Over this bar there is now some 20 inches of water, owing, in part, to the dam previously constructed.

Former improvement consisted in a riprap and timber dam extending from a small "towhead" half way across the bar, toward the right bank; present length about 800 feet, thus shutting off about one-half of the river, giving the majority of the water to the left-hand channel or passage. It is proposed to repair, enlarge, and lengthen this dam, to remove a few loose boulders, and excavate the gravel from the channel way.

Estimate of quantities necessary to make this improvement.—Removal of 50 cubic yards of loose rock; removal of 300 cubic yards of gravel; construction of 1,500 cubic yards of riprap dam.

7. *King's Bar*,

situated about one hundred and five miles from Chattanooga. This obstruction is similar to that at Shield's dam, the water being but 18 inches on this bar.

No former improvements.

Proposed improvements consist in the construction of wing-dams, arranged to increase the water by accumulation over the bar; to remove a small quantity of the solid rock from the passage-way; to remove some few loose boulders and snags that now obstruct this passage.

Estimate of quantities necessary to make the improvement.—Removal of 100 cubic yards of solid rock; removal of 75 cubic yards of loose rock; removal of 5 snags; construction of 1,800 cubic yards of riprap dam.

8. *Turner's Bar*,

situated about one hundred and twenty miles above Chattanooga. The obstructions at this point are similar to those at Watt's Bar, except that the reef extends for nearly three-quarters of a mile. The passage-way is good, however, save at a few points. The water over the bar is about 15 inches; in the passage-way generally about 3 feet.

It is proposed to widen and straighten the existing passage by removal of the solid rock bottom; to remove certain boulders and detached rock and certain snags.

Estimate of quantities necessary for this improvement.—Removal of 500 cubic yards of solid rock; removal of 100 cubic yards of loose rock; removal of 10 snags.

9. *Caney Creek Shoals*,

situated about one hundred and twenty-one miles above Chattanooga, about four miles below Kingston. The obstruction consists of a rocky bar, extending across the river and down some half a mile of detached rock reefs and loose boulders in the channel. The water on the bar is about 20 inches, owing to former improvements. The river is divided into two parts by a large island.

Former improvements.—First improved by Colonel Long in 1832, by the construction of riprap dam across the river at the head of the island, thus forcing the water to the right and left, the right chute being the steamboat channel, and the other used, at that time, for mill purposes. This dam was of little use to the right channel, as the water not being confined in any way, or, but for a short distance, spread out over the wide reach of river between the island and the right bank. In 1856 an additional dam was constructed under Colonel McClellan, to improve the right chute; this dam was more successful, but owing to abrasions and decay considerable water wastes over it. There being but a short lateral or confining dam, no benefit is secured to the rocky reefs below the rock-bar, and they are now the principal obstruction.

It is proposed to increase, enlarge, and repair the dam of 1856, to extend the lateral or confining portion of that of 1832, and to remove a portion of the 1832 dam at the head of the island, thus opening the left chute, which is, with the exception of a single reef, the best channel at present. It is also proposed to excavate a channel-way through the reefs in the right chute, and to remove some gravel from the bar. The left chute could be more easily improved, but it is feared that the current would be too swift for ascending boats, as this chute is nearly a mile shorter than right chute, giving a much more rapid current.

Estimate of quantities necessary for this improvement.—Removal of 500 cubic yards of solid rock; removal of 100 cubic yards of loose rock; removal of 500 cubic yards of gravel; construction of 1,800 cubic yards of riprap dam.

RECAPITULATION.

Approximate estimate of quantities.

Order.	Names of obstructions.	REMOVAL OF—				Cubic yards of rip-rap dams.
		Cubic yards of solid rock.	Cubic yards of loose rock.	Cubic yards of gravel.	No. of snags.	
1	Sandy Creek Shoals	100	200	100	10	1,800
2	Kelley's Shoal	900	100	....	...	....
3	Watt's Bar	200	50	....	...	....
4	White's Creek Shoals	200	100	400	5	1,800
5	Half Moon	500	100	200	20	2,100
6	Shield's Dam	....	50	300	...	1,500
7	King's Bar	100	75	....	5	1,800
8	Turner's Bar	500	100	....	10	....
9	Caney Creek Shoals	500	100	500	...	1,800
	Total amount	3,000	875	1,500	50	10,800

The benefit to be derived from the above work may be briefly stated as follows:

The removal of the above enumerated obstructions would open up to continuous navigation one hundred and twenty-five miles of river for steamboats and other craft drawing 3 feet of water. As it now is, the river is only navigable for such steamers during seven months of the year, and during a part of the remaining five months it is impossible for boats drawing 1 foot to navigate across these obstructions. That the resources of the section of the country through which this portion of the Tennessee River flows are large and in every way worthy of such expenditure of the public funds is a fact well known, and were the river navigable throughout the year the commerce of the Tennessee River between Chattanooga and Knoxville, already of no mean character, would be largely increased. No railroads penetrate the belt of country adjoining the upper river, so that the stream affords at present the only economical means of transporting the agricultural and mineral wealth of this region to market. Seven steamers are now employed in the trade between Chattanooga and Knoxville, which latter town is justly the head of low-water navigation, and should be so regarded in all estimates and appropriations for the improvement of the Upper Tennessee.

Respectfully submitted.

L. COOPER OVERMAN,
Captain Corps Engineers.

Major WALTER MCFARLAND,
Corps of Engineers, Chattanooga, Tennessee.

UNITED STATES ENGINEER OFFICE,
New Orleans, Louisiana, July 20, 1871.

GENERAL: I have the honor to submit the following report of progress made in all works of river and harbor improvement under my charge for the fiscal year ending June 30, 1871.

I.—IMPROVEMENT OF THE MOUTH OF THE MISSISSIPPI RIVER AT SOUTHWEST PASS.

In my letter to the Chief of Engineers, dated April 19, 1870, I had the honor of recommending certain additions to the machinery of the dredge-boat employed on this work, and to advise that the work of making them be proceeded with at an early day in order to give time for completing them and testing their efficiency before the active commercial season at this port should set in, and render both continued and effective work on the bar of the first importance.

The additions proposed were designed to give to the excavating propeller of the dredge-boat increased efficiency as a dredging-machine by confining its action while at work to a limited area of the bar and by directing to the best advantage the resulting currents. They had for a further object the protection of the blades of the propeller from frequent damage.

On the 1st of July, 1870, the dredge-boat (Essayons) having suspended work on the bar at Pass à Loutre, was at the wharf in this city awaiting the repairs and additions recommended.

On July 5 a letter approving my project was received, and the work of carrying it out at once commenced.

Notwithstanding my close personal superintendence of this work, it was not completed until the 14th of October. My own illness and the outbreak of the yellow fever on board the dredge-boat, resulting in the loss of my able chief steam engineer, Mr. John F. Robinson, then prevented a test of the new machinery before the 31st of October.

On the latter date work on the bar at Southwest Pass was commenced and continued during 1st, 2d, and 3d of November. The time of actual work on the bar was twenty-eight and one-fourth hours. October 30, careful soundings over the bar showed a channel across, (a gulley made by dragging vessels over,) having through it at mean low tide a depth of but 16 feet for a length of about 1,400 yards. On the afternoon of November 3 there was available a channel about 50 feet wide at the narrowest point, and 19 feet deep, which shows an amount of deposit excavated during the four days' work approximating 22,400 cubic yards.

On November 4 there were five cases of yellow fever reported on board the dredge-boat, and I was obliged to suspend work to bring the sick to this city for medical treatment, and the vessel for disinfection.

On November 19th work was recommenced at Southwest Pass. The following extracts from my monthly reports of progress show with what success:

Report of December 6.

November 19.—Work on the bar at Southwest Pass was recommenced. Worked three three hours, and was stopped by bursting of a steam-valve.

November 20.—(Sunday;) no work.

November 21.—Stormy; and bar too rough for work.

November 22.—Storm continued; prevented work.

November 23.—Worked four hours forty-five minutes.

November 24.—Bar too rough for work and vessels aground.

November 25.—Worked three hours forty-five minutes; ship blocking channel.

November 26.—Worked two hours; ship yet blocking channel.

November 27.—(Sunday;) no work.

November 28.—Worked six hours and forty-five minutes.

November 29 and 30.—Too stormy for work.

December 1.—Worked five hours and fifteen minutes.

December 2.—Worked six hours. On this date Captain J. W. Wilson, master of Essayons, reported, by telegraph: "Least depth of channel at mean low tide, 18 feet; width between outer lumps, 112 feet; least width of channel above lumps, 132 feet.'

December 3.—Worked seven hours and ten minutes; and the following list of soundings was reported, (tide $\frac{1}{10}$ of a foot below mean low tide:) From Wreck buoy to Cleopatra buoy 18½, 17½, 17½, 18, 19, 18½, 19, 19, 18½, 18 feet. From Cleopatra buoy to outer lumps, 19, 19, 20, 20, 18½, 17½, 21, 20, 20, 19, 19, 18½ feet.

Report of January 4, 1871.

Work with the Essayons at Southwest Pass was steadily continued during December.

* * * * * * *

Several unimportant accidents occurred to the engines and dredging-machinery, necessitating repairs which were made on board ship, causing but slight delay in the work of dredging. Unusually stormy weather was experienced, causing considerable delay. Delay was also caused by general use of the channel worked by the Essayons. Perhaps much of this delay might have been avoided had I not instructed Captain Wilson to take no risks by working in rough weather or while vessels were crossing the bar. The rapidity with which work can be done, under favorable circumstances, makes it unnecessary for us to risk anything.

* * * * * * *

Captain Wilson reports, December 31, 4 p. m.: A channel 18½ feet deep (least) and 154 feet wide, at mean low tide. This will accommodate the deepest-draught ships coming here. I propose to widen the channel to 200 feet, and then confine work to keeping it open during the winter and to further deepening it.

* * * * * * *

The river now is rising very slowly, and our work is done during the day-time on the incoming tides.

Report of January 31.

January 2, 3, 4 and 5.—A total of twenty-seven hours' dredging closed with the result stated in the following extract from report of Captain J. W. Wilson, viz: "On the afternoon of January 5, the channel opened by the Essayons at Southwest Pass was 18½ feet in depth at a remarkably low tide, and 215 feet in width, full length of the bar. There are no lumps in the channel."

* * * * * * *

It being necessary at this time to resupply the ship, she was ordered, with the barge in tow, to start for this city on the 6th. She arrived here on the 7th. Had it been considered necessary to do so, she could have returned to Southwest Pass on the 11th. I desired to keep her here for several reasons, stated as follows:

1st. We left as good a channel at Southwest Pass as could be desired.

2d. The river had been at a low stage (from 14½ feet to 15 feet below high water of 1862 at New Orleans) for a long time, and I wished to ascertain how much filling would take place in the channel during a reasonable time, under the existing conditions, if not disturbed by dredging. Two weeks was the time set for the experiment, and a close watch was kept to see that commerce was not inconvenienced by allowing too much filling.

3d. In the mean time I could change ballast and stop leaks in sinking tanks, so that on recommencing work the vessels could be sunk for working to the greatest depth attainable.

4th. I could also have time for making general repairs to the coal-barge, such as have been heretofore reported desirable.

5th. I could economize in coal, which, owing to a temporary blockade at Louisville, had run up in cost to $18½ per ton.

January 23.—Work on the bar was resumed. A careful examination showed that but slight change in depth and width of channel had been effected during the interval between the 5th and 23d. Five and one-sixth hours' work was done on the 23d. Six and a quarter hours on the 27th. Stormy weather prevented further work. My orders to Captain Wilson were to work only every other or every third day, if he found that by so doing he could maintain a good channel. The saving effected by this course would amount, on an average, to $100 per day not worked. On the 26th Captain Wilson reported: "Ships drawing 17 feet sail in, and vessels drawing 18 and 18½ feet tow in without trouble."

Report of February 28.

The Essayons was at work on the bar at Southwest Pass during the 1st, 2d and 3d—total time, 13½ hours—leaving a channel 260 feet wide and 19 feet in depth at mean low tide. This work was done with but three blades in the excavating propeller, one having been previously broken on obstruction in east mud-lump.

On the 4th, while passing Stake Island, the excavating propeller struck a sunken wheel and shaft, (the presence of which was not before known,) and sustained very serious damage. One blade of the propeller was broken entirely off; the other two were partially broken off; the plow-handle was broken in two; the propeller-shaft was badly bent; the shaft-casing and sleeves damaged so that they had to be replaced by others, and the propeller-hub slipped. * * * * *

NOTE.—Repairs were at once commenced, and work on them continued during the month.

During the delay there has been no complaint about obstructions at Southwest Pass. No vessels have grounded on the bar, to the best of my information, although many have passed over.

The river at this place (New Orleans) stands 6 feet below high-water mark of 1862, and a flood equal to that of 1862 is anticipated.

Report of April 1.

Repairs were not completed until the 8th of March, on which day the Essayons sailed for Southwest Pass. She arrived there on the 9th, and recommenced work on the 10th, under the most adverse circumstances. At that date the 19-foot channel we had left when suspending work in February, and which had retained (according to the best information) the dimensions left in February, until about the 1st of March, was found filled in by deposit so as to give but 15 feet, and the bar had moved out into the Gulf a distance of about 400 feet. There was also a large ship aground in and across the channel, obstructing the latter so completely that, after five hours spent in the attempt, we were unable to pass out or do effective work.

Afterward the tow-boats succeeded in dragging the ship off the bar, and we started out, but were stopped by an attempt on the part of the tow-boat captain in charge to run us down. In the effort to prevent a collision we broke a blade of the excavating propeller. The ship was then again forced on the bar, and anchored so as to again blockade it.

On the 11th, at the urgent request of the United States district attorney, charged with the defense of the suit of Wolfley *vs.* Humphreys *et al.* the "Essayons" was ordered to New Orleans that her officers might be able to appear as witnesses in suit named.

During her stay in New Orleans a new blade was put in the propeller.

On the 20th she again left for Southwest Pass, arriving there on the 21st, and working on the bar eight hours that day. During the 22d she worked 9⅚ hours, but with so much interruption from vessels, in and out, that but little was accomplished. The 23d and 24th were stormy, and the bar blockaded. On the 25th, with the bar yet blocked, we succeeded in working two hours.

Steps I had taken to assume control of the bar to such extent as might be necessary for the interests of the work, at this date induced the managers of the tow-boat association to agree not to interfere with the work, as they had before done by grounding vessels on the bar at improper times and blocking it.

Since the results of our work have been for each day noticeably good, viz, on the 27th there was reported 16¼ feet at low tide; on the 28th, 17 feet low tide, and on the 30th, 18 feet at low tide, with a channel width of 100 feet. * * *

During the time of this work the river stood at 2¼ feet below the high-water mark of 1862, as noted at New Orleans.

NOTE.—Since found to be a mistake caused by moving old gauge, and placing high-water mark 1 foot and 6¼ tenths too high. * * * * *

Report of May 2.

* * From the 30th of March to the 4th of April the weather was very stormy and the bar too rough for work. During this time the channel filled in so as to leave only 16¼ feet on the crest of the bar. On the 4th work was commenced and two blades of the excavating propeller broken. These were replaced, and work recommenced April 13th.

Between the 13th and the 28th the Essayons could only work on the bar forty-five hours, on account of bad weather. In this short time favorable for work she deepened the channel to 18½ feet from 16¼ feet.

Two blades were broken on the 28th. The "Essayons" arrived here yesterday and went into dock this morning.

The hub will now be fitted with pointed blades. This work will be completed in two or three days. * * * * * * *

No monthly reports for May and June have been rendered. Their place is supplied by the following statement of work to the close of the fiscal year.

Work was resumed on the 8th of May, with a channel over 18 feet deep; continued on the 9th, and suspended on the 10th by a severe storm, which filled the channel so that on the 11th soundings only indicated 16½ feet. The 11th, 12th, 13th, and 15th afforded twenty-six hours' working, which had only the effect of deepening the channel above and below the crest of the bar. On the 16th six and a half hours work resulted in cutting through this crest and increasing the depth to 17½ feet.

Between the 16th and 28th storms prevented work, except at intervals, twenty hours and a half in the. aggregate. On the latter date the depth of the channel was reported at 17¾ feet, with but three sounds of less than 18 feet. Stormy weather again prevented work until June 1st, when, after eight hours' working, a depth of 17 feet was reported. A storm of more than usual violence then set in and prevented work until the 7th, on which date, and on the 8th, seventeen and a half hours' work were accomplished, opening the channel, which, during the storm had filled to 15¾ feet, so as to give 16¾ feet. Another severe storm, lasting four days, then put a stop to work and refilled the channel to 16 feet.

From the 13th to the 23d forty-two and a half hours' work was performed, giving on the latter date a depth reported at 17 feet, large. Five days of this period were spent in resupplying the dredge-boat with coal, provisions, and other stores needed to last for the next two months.

On the 25th, 18 feet was reported, and the same for each succeeding day until the 30th, when 18½ feet for a width of channel of 250 feet was found available.

On the 30th the ship Francis P. Sage, drawing 19½ feet, passed out without the least trouble.

The two months covered by this portion of my report were remarkably unfavorable for work at Southwest Pass, where the effect of storms is not only felt during their continuance, but often for several days afterward, owing to the exposure of the bar to every southerly storm, and to the heavy swell resulting from waves which have an unchecked fetch across the whole width of the Gulf. Even storms which expend themselves over the Gulf cause a rough bar, and from this effect of such storms we have been obliged to suspend work on days at Southwest Pass calm and without a cloud in the sky. During the months of April, May, and June, twenty-seven such days were recorded on which either work was partially or wholly suspended.

In concluding this account of this past year's work I cannot show the value of its results better than by calling attention to the fact that no blockade has occurred during the year such as has occurred every previous year.

Of the great number of vessels engaged in the commerce of this port but a very few since November 1, 1870, have met with detention on the bar; none have been detained longer than a few days, and of these the majority have been grounded outside of the channel at times when there was at least 18 feet available at mean low tide, and the channel marked by a line of spar-buoys on each side. No other year has passed without a blockade, and the detention of a large fleet for weeks and even for months. During previous years even steamers have been obliged to obtain the assistance of tow-boats at great expense, and then be detained for days. During the past year I know of but one steamer (the Western Metropolis, draught 18¾ feet) that has been at such expense, and she only incurred it because her pilot ran her out of the channel and into 12 feet of water.

A NEW DREDGE-BOAT.

In the early part of the fiscal year Congress made appropriation sufficient to admit of the construction of another dredge-boat. Before commencing this construction a thorough trial of the new machinery applied to the Essayons was considered desirable.

On January 12, 1871, I was able to report this trial satisfactory, and recommended that contract for the new boat be made as soon as practicable, the vessel only to differ from the one in use in certain points specified in my letter.

The recommendation was concurred in by the chief of engineers and authority given me to prepare drawings and specifications and to advertise for bids from ship-builders.

With the assistance of Mr. Edward Marsland (a man of ability and long practical experience as a mechanic and steam engineer) the necessary specifications were completed and advertisements issued on the 23d of March.

In response bids were received as set forth in the following abstract:

Abstract of bids received for the construction, equipment, and delivery at New Orleans, La., of a dredge-boat for improving the mouth of the Mississippi River.

No. of bid.	Bidders' name and residence.	Bondmen's name and residence.	Voucher.	AMOUNT BID FOR.	
				Wooden hull.	Iron hull.
1	Atlantic Works, Boston.	W. C. Hibbard, Franklin Smith, Boston.	T. Russel, collector of port, Boston.	*$245,000	*$270,000
2	H. F. Rowland, New York.	G. W. Quintard, Henry Steers, New York.	Noah Davis, United States district attorney, New York.	†225,000	†253,000
3	John Roach, New York.	F. F. Rowland, Brooklyn, D. L. Peter, New York.	Noah Davis, United States district attorney, New York.	†218,300	†246,500

*Subject to deductions, as specified in paper attached to bid. †No specifications attached.

I certify this to be a true abstract of the original bids.

C. W. HOWELL,
Captain of Engineers, U. S. A.

The lowest bid for construction with an iron hull being greater than the available amount of the appropriation would admit, that for a wooden hull was accepted, and the contract was awarded to Mr. John Roach, he being the lowest bidder.

Mr. Roach entered into contract and commenced work on the machinery in May. On the 30th of June work on both hull and machinery was well advanced.

The contractor has agreed to deliver the vessel fully equipped and ready for work in New Orleans on or before the 1st of January, 1872; he expects to deliver at an earlier date. There is good reason to feel gratified in every way with the contract, the work being in the hands of as good builders as there are in New York, and the terms being nearly $5,000 less than for the "Essayons," although the dimensions of the hull are greater and the machinery more expensive.

I have employed two thoroughly reliable inspectors to superintend the work, and insure the use of none but the best material and workmanship.

It is greatly to be regretted that the amount of appropriation available was not sufficient to warrant the construction of an iron hull. When we consider that the latter would live about twice as long as a wooden hull, the few thousand dollars difference in cost appears insignificant.

BARGE CAVALLO.

During the month of February extensive repairs were made to the barge, used as a tender to the "Essayons," at a cost of $3,740. In the judgment of experts she is now in condition to last without further repairs for three or four years. At the end of that time it will be advisable to purchase a new tender.

STEAM-LAUNCH.

Early in March I had completed, at a cost of $3,000, a steam-launch for use in making surveys. The purchase of a vessel of this kind was recommended in my last annual report, and authority to purchase received in December. The launch measures 37 feet in length, 8-foot beam, 5-foot depth of hold. She is provided with a horizontal boiler, a vertical engine, and a 36-inch screw, calculated to give her a speed of five miles per hour against the flood-current of the Mississippi. This speed has been exceeded. She was fitted up with a cabin, kitchen, and lockers, and carries a crew of four men, with provisions and coal to last three days constant steaming. The advantage derived from her use to date has already gone far toward repaying her original cost.

SURVEYS, ETC.

In accordance with the plan laid down in my last report, I have extended the series of surveys and observations commenced in 1869. The information obtained is not nearly so complete as I expected, owing primarily to the difficulty experienced in securing a suitable person to place in charge of the work. Secondarily, to the late date on which the steam-launch was made available, and to the later date of receiving the self-registering tide-gauges ordered early in last November. The self-registering anemometers ordered at the same time have not yet come to hand.

It is only within the past month that my civil assistants have been able to regulate and put in running order all the tide-gauges. Imperfect gauge records have been kept at Pass à Loutre, the head of the passes, and at Southwest Pass, by the light-house keepers at those places. Surveys have been repeatedly made at both passes, as well as careful observations to determine the effect of the various agencies at work to form the bars, and of the dredging, to open a channel at Southwest Pass.

None of these observations, except those relating to the action of the dredge-boat, are reported, being withheld to await the results of observation during the present fiscal year.

In this department of my work I have severely felt the want of an engineer officer in active personal superintendence throughout the year. The two officers on service with me during the past year have been the greater part of the time required on other duties. During such short periods as I have been able to detail one of them for duty at the mouth of the Mississippi, there has been a marked improvement both in the work of dredging, in the value of surveys made, and in the general administration of the work. During the coming working season the want will be yet more seriously felt, since (unless another officer is detailed for duty with me) I shall be obliged to trust entirely to such civil assistants as I can employ.

CONTROL OF THE CHANNEL.

I have several times represented the necessity that exists for giving the engineer in charge of this work sufficient legal authority over the use of the channels excavated across the bars, to enable him to select his time for work, to prevent interference with it, and to prevent the passage of vessels at unseasonable times.

Authority to direct crossing of the bar is now vested in a number of persons more or less independent, and subject to no sufficient penalty for damage they may inflict upon commerce in any other way than by collision. Managers and captains of tow-boats, bar-pilots, and ship-masters are of this class. Any one of them can, at his own pleasure, either with or without a knowledge of the channel and the currents through it, attempt a crossing, force the dredge-boat from her work to make way for his vessel, and perhaps obstruct work for days, causing deterioration of the channel, without its being in the power of any one to call him to account for his action.

Our work has frequently suffered annoyance from this heedless state of affairs, usually either because of the impatience of ship-masters, ignorance of pilots, or intention of tow-boat captains.

In a previous communication I have stated reasons why the tow-boat association do not desire improvement of the natural crossings over the bars, and have cited instances in which I am positive its employés have maliciously grounded vessels, so as to either blockade our work or to cause deterioration of the channel we had formed. Vessels drawing less than 17 feet have been grounded by them on the sides of a channel 18½ feet deep at mean low tide, (20 feet at high tide,) 250 feet wide at its narrowest point, and its limits marked on each side by a line of spar-buoys. All groundings on the sides cause rapid deposits and changes in the channel, and add greatly to the labor and expense of keeping it open. This work is not the only one subject to annoyance and damage from unlimited public license. I extract the following from a report of Major William E. Merrill, found on page 416, Report of the Chief of Engineers for 1870:

> "We need very much some laws to protect our works after they are built, and to regulate the extent to which cities and individuals shall be permitted to encroach upon the river channel. At present there seems to be no authority anywhere to protect works built for the common good from being destroyed by any individual who may feel himself aggrieved, nor to prevent cities from building out into the stream to any extent, regardless of the effect upon navigation or individual rights."

The work at the mouth of the Mississippi, which at best can be made but a deep, narrow, and well-defined canal under existing regulations, can at any time, to suit the whim or serve the interests of any individual of the classes I have named, for a period be rendered valueless.

I have already reported the beneficial results following my assumption of control at Southwest Pass in March, 1871. I can of course do the same again should a like emergency warrant it, but yet without legal right or power to make my regulations respected should the parties interested choose to act contrary to them.

I submit for consideration the draught of an act of Congress required to give me the necessary authority. (See Appendix.)

The following financial statement is submitted:

Balance on hand June 30, 1870	$2,799 76
Received from appropriation of 1869	20,000 00
Available from appropriation of 1870	300,000 00
Available from appropriation of 1871	125,000 00
Total available since June 30, 1870	447,799 76
Expended during fiscal year ending June 30, 1871	140,520 96
Available June 30, 1871	307,278 80

In United States Treasury, Washington	$306,228 97	
In United States Treasury, New Orleans	608 70	
In office safe, New Orleans	441 13	
		$307,278 80
Amount of contract for new dredge-boat	218,300 00	
To be returned to Treasury, appropriation 1869	7,000 00	
		225,300 00
Available for work to June 30, 1872		81,978 80

No outstanding indebtedness.

The following statement of the commerce benefited by the work has been received from the collector of the port of New Orleans, and is submitted:

Number of entrances at this port, steam	916
Tonnage	949,230.06
Number of clearances at this port, steam	1,201
Tonnage	1,231,161.15
Number of entrances, sail	1,091
Tonnage	562,824.46
Number of clearances, sail	1,141
Tonnage	566,415.69
Total value of imports dutiable	$18,185,294 00
Total value of imports free	1,145,825 00
Total value of exports, domestic	93,953,081 00
Total value of exports, foreign	1,293,710 00
Total revenue collected on imports	5,899,390 85

The excess of clearances over entrances arises from clearances of coastwise vessels with merchandise in bond.

Project for the year ending June 30, 1872.

During this year it is proposed, first to make necessary repair to the Essayons, the extent or cost of which cannot now be correctly estimated. Afterward (all repairs being completed) to resume work on the bar at such times as it may be required to accommodate the fleet of vessels usually arriving in the early part of the winter.

On the arrival of the new dredge-boat, she will be placed at work, relieving the "Essayons." The latter will then be held in reserve or put to work at Pass à l'Outre, as may be hereafter directed by the Chief of Engineers.

The steam-launch will be retained at the mouth of the river with a surveying party, to continue tidal and other observations, and to make surveys of the bars, as may be required from time to time during the summer.

The barge Cavallo will be kept at the head of the passes for the use and supply of the surveying party.

Estimate.

An additional appropriation of $30,000 is asked for the fiscal year ending June 30, 1872.

An appropriation of $125,000 is recommended for the fiscal year ending June 30, 1873.

The work is not susceptible of permanent completion. It is located in the collection district of New Orleans, and at Southwest Pass, near the light-house at the entrance to that pass.

II.—IMPROVEMENT OF BAYOU TECHE, LOUISIANA.

An act of Congress approved July 11, 1870, appropriated for this work the sum of $17,500.

By letter of July 19, 1870, I was directed to proceed with the work contemplated by the act, in accordance with a project submitted in my report of June 14, 1870.

August 12, advertisements were issued soliciting bids for performing the work by contract. September 20, I was obliged to report that no bids had been received, and to recommend the prosecution of the work under the immediate supervision of this office. The unhealthfulness of the season prevented further action until December, 1870. Agreement was then made for the construction of a wrecking-flat suited to the work to be done. This was completed, and delivered at Brashear City early in February, 1871. The flat was then equipped, a working-party employed, and work commenced February 15, under the superintendence of Mr. D. M. Kingsbury. Work was continued from that date until June 30, when, owing to the high stage of water in the bayou, it was considered advisable (on the score of economy) to suspend until the next low-water season.

The work has resulted in clearing the bed of the stream of all obstructions found between its mouth and the town of New Iberia.

During the fiscal year ending June 30, 1872, it is proposed to complete the work to St. Martinsville.

It is believed that the cost of completed work will fall considerably under the amount of the appropriation.

Financial statement.

Amount appropriated		$17,500 00
Expended to June 30, 1871	$8,363 83	
Outstanding indebtedness	260 00	
		8,623 83
Total available		8,876 17
In United States Treasury, Washington	7,000 00	
In United States Treasury, New Orleans, (debts paid)	1,876 17	
		8,876 17

No appropriation is asked for the fiscal year ending June 30, 1872.

The work has benefited the local and coastwise commerce of the bayou as far up as New Iberia.

It is located in the collection district of New Orleans. The nearest light-house is that at the entrance to the Atchafalaya River.

III.—IMPROVEMENT OF THE INNER BAR AT THE ENTRANCE TO GALVESTON HARBOR, TEXAS.

By act of Congress approved July 11, 1870, there was appropriated for this work the sum of $25,000.

By act approved March 3, 1871, a further appropriation of $20,000 was made.

By letter dated "Office of the Chief of Engineers, Washington, D. C., July 20, 1870," I was directed to submit a project for the prosecution of the work, in accordance with a plan for excavating and preserving a channel 12 feet deep and 80 feet wide, across the bar, by the ordinary method of dredging.

It was then recommended that the work be done wholly by contract.

The prevalence of yellow fever along this coast prevented further action until December 15, 1870, at which date I caused to be made a survey, to afford data for an advertisement requesting bids for the work.

Advertisement was issued on the 19th of December; a copy is appended.

In answer, but two bids were received, one from E. B. Bishop, and one from John Halliday; copies appended.

February 15, 1871, both bids were rejected, for reasons evident after their perusal.

It was then proposed to hire a dredge-boat, scows, and tug-boat, to purchase in open market fuel, provisions, and other supplies necessary, and to employ the labor required to prosecute the work direct from this office.

After much time spent in search of an available dredge, I was forced to abandon this project, all dredges on this coast being fully employed on more remunerative work.

April 11, 1871, authority was granted me to purchase a dredge-boat, scows, and tug. Negotiation for the purchase of a Morris & Cummings dredge, employed near New Orleans, was at once commenced. The owners residing in New York, and having other offers than the one made by myself to consider, did not give me a decided answer until early in May. They then offered to sell, delivered at Galveston, for $30,000, giving preference over a bid of that amount from another party. This price was considered excessive and the offer declined.

An agreement was then made with Morris & Cummings to build a dredge-boat and deliver at Galveston within one hundred working days from date of agreement, for the sum of $25,000; (a copy of the agreement is appended.) Work on this boat is progressing well.

On the 14th of June an agreement was made with Mr. J. H. Lynch, of New Orleans, to build and deliver at Galveston, within sixty days, two first-class stump-scows, as per drawing and specifications given him, for the sum of $5,600. Work on these is well advanced. It is not yet decided whether to provide a tug-boat by hire or purchase.

Should no unforeseen cause for delay prevent the builders of dredge and scows from complying with the terms of their agreements, I expect to commence the work of dredging about the middle of September. It will be placed in charge of a civil assistant, who will hire men, purchase supplies, and conduct the work under orders from this office.

Financial statement.

Appropriation of July 11, 1870		$25,000 00
Appropriation of March 3, 1871		20,000 00
Total appropriation		45,000 00
Expended to June 30, 1871		176 76
In United States Treasury, New Orleans	$1,823 24	
Total available June 30, 1871		44,823 24

Obligations contracted:		
For building dredge-boat	$25,000 00	
For dump-scows	5,600 00	
		$30,600 00
Balance		14,223 24
Estimated cost of tug-boat		7,000 00
Available for prosecuting work		7,223 24
Estimated cost of work from October 1, 1871, to June 30, 1872		11,000 00
Deficiency		3,776 76

Estimates.

Additional appropriation asked for fiscal year ending June 30, 1872	$4,000 00
Appropriation recommended for fiscal year ending June 30, 1873	16,000 00
Total	20,000 00

The work is not susceptible of permanent completion.

It will benefit much of the commerce of Galveston, Texas; the amount I have not been able to ascertain. It is located at the entrance to Galveston Harbor, in the collection district of Galveston, and near the light-house on Bolivar Point, Texas.

A PROJECT FOR IMPROVING THE ENTRANCE TO GALVESTON BAY AND HARBOR, SO AS TO ADMIT VESSELS DRAWING EIGHTEEN FEET.

1st. Considerations on which the project is based.

On examination of Coast Survey and other charts of the Texas coast, there will be observed a striking general resemblance between the entrances of all its harbors. The coast itself is for the greater part of its length but a succession of long narrow sand islands, between which debouch these entrances or passes. Behind the islands are large bays or lagoons, forming tide reservoirs, into which water from the Gulf of Mexico is daily ponded during flood-tide, and from which it is daily discharged during ebb-tide, through the passes. The scour of the current thus created gives a navigable depth of channel between the islands, where both ebb and flood currents work to this end. At their inner extremities these channels are lost in the shoal water of the bays; at their outer, in a bar separating them from the deep water of the Gulf. These bars are formed on the lines, where, owing to the expansion of the passes, the ebb-current loses all eroding effect on the bottom.

Were no opposing agencies at work to prevent it, the line of deepest water across the bar (theoretically) should be formed along the axis of the pass, and the first method for improvement suggested would be that of converging jettees, extending from the islands beyond the crest of the bar, and on either side of the axis. It is evident, however, in the case of these Texas bars, that other agencies are at work to modify the shape of the bars, and give the main channel across them other than a normal direction. These should receive consideration in forming any plan for improvement of the crossing.

1. It is first observed that the bars are all formed of similar deposit, namely, a quicksand, compact but easily moved by currents of water, making it dangerous for vessels to ground upon them, except in calm weather.

2. At each of these passes the southern headland projects further into the Gulf than the northern; this is particularly noticeable at Galveston, San Luis Pass, Aransas Pass, and Pass Cavallo; also that in all cases this headland is gradually wearing away, and the passes either deteriorating from failure of the northern headland to follow out, or maintaining a constant depth in cases where the latter extends southward as the former is worn away.

3. By reference to the charts, it is seen that the main channels, after passing outside the headlands, are gradually deflected to the southward, on the way sending off one or more minor channels to the east, the only exceptions being at the mouth of the Brazos River and at Brazos San Jago. This deflection would not occur but from some cause not found in the nature of the bars; it must be credited to one of two natural forces opposing the direct flow of the ebb-currents into the Gulf, or perhaps to both, viz:

1st. The prevailing winds are known to be from the eastward, and, crossing the passes obliquely, no doubt have an influence in determining the direction of the channel across the bars.

2d. There is reason to believe in the existence of a littoral current, sweeping along the coast north to south, and having a decided influence on the formation of these bars. It is not proposed to discuss or give reasons for this belief, since it is entirely founded on theory derived from the existence of the Gulf Stream, the shape of the coast, the degradation of the southern headlands of the passes, and the direction of the main channels across the bars named. Its existence offers an explanation for these, and I think is fairly to be presumed, especially since I know of but one effort to discover it, and that at the mouth of the Mississippi River, where it should be so obscured by the river currents as to make it imperceptible.

Assuming the effect ascribed to the prevailing winds and littoral currents, I illustrate by reference to a chart of Galveston Bar Harbor and Entrance, which I inclose.

On this I have marked the axis of the pass; the direction of the several channels across the bar, shown by the lines H B, A C, A D, and A E; and the direction of a littoral current assumed parallel to the general direction of the shore-line; also the approximate limits of prevailing winds.

The channel H B is in the direct line of the littoral current, and it is noticed that where this strikes the current from the pass, the latter receives its first marked deflection. The 6 and 12-foot curves off Bolivar Point indicate a Gulf current along the shore in the direction B H, the existence of which is quite substantiated by the deflection referred to.

From the line H B to the line of the main channel, A E, a further deflection is marked, (the latter being nearly perpendicular to the axis of the pass,) and is best indicated by the line of the 12-foot curve, although, for the purpose of showing the compromises between the opposing currents, I have marked the two minor channels A C and A D.

Finally, the currents along A E, after crossing the bar, is evidently entirely overcome, the 12 and 18 foot curves showing the formative action of a littoral current sweeping along the front of Galveston Island.

The continual pressure (here indicated) of the water toward the head of Galveston Island at ebb-tide should result in the constant erosion already noticed, and the transport of the eroded material to be deposited along the face of the island. At flood-tide similar erosion should take place, and the material be carried to form Pelican Island, Pelican Spit, and finally to form the inner bar at the entrance to Galveston Harbor.

There is shown on the chart the shore-line at Fort Point as it was in 1867. I have marked the shore-line, accurately determined by Lieutenant H. M. Adams in December, 1870. The amount of erosion thus shown to have taken place in three years serves to form a rude estimate as to the date on which the head of Galveston Island covered what is now marked the "Middle Ground Breakers," when "Pelican Spit" was but a shoal and not sufficient barrier to prevent sand eroded from the island from passing clear of the entrance to Galveston Harbor, and when this entrance afforded a depth of 30 feet, a depth it is currently believed to have had when Texas was first settled. However true or false this tradition may be, (and there is no positive proof to support it,) it is certain that within the past few years the entrance has continued to shoal, and not from any diminution of the volume of water poured through it, but from the depression of this volume over a wider area, due to the erosion of the head of Galveston Island and deposit of a portion of its material in the channel.

In view of the facts in the case, it does not appear improbable that, unless effective measures are taken to prevent such a catastrophe, the finest harbor on the coast of Texas will be rendered valueless for any except a smaller class of coasters than those now monopolizing the greater part of the Texas trade.

Having paid considerable attention to the subject of harbors in Texas, and to the various plans proposed for improving the entrance to the harbor of Galveston, I beg leave to submit the following project:

'First. I would recommend the construction of a breakwater along the crest of Galveston Bar, as indicated by the line F G on the chart. This would act as a single jettee to concentrate the discharge of the pass through the main channel A E. It would admit between its northern extremity and Bolivar Island as much of the littoral current as can be utilized to re-enforce the current of the pass. It will protect in a great measure the head of Galveston Island from erosion. It will inclose a good outer harbor. It will throw the whole discharge of the pass along a line making such an oblique angle, at its debouch with the littoral current, as to least favor deposit beyond it.

Second. Having completed the above, to then construct a jettee along the line marked J I. This will extend the head of Galveston Island to its original position on the "Middle Ground Breakers," throw the whole discharge past Galveston directly into the main channel of the pass, and, it is apprehended, will have the effect of washing away the inner bar, and of widening Galveston Harbor.

Third. Measures should then be taken, if necessary, for further protecting the head and face of Galveston Island from erosion. It is presumed, however, that this will not be necessary.

The work of building the outer breakwater should be commenced at its northern extremity, and its length be determined by its effect. The greatest length possibly required will be that shown on the chart—about three and a half miles. It should be built with a rough grillage foundation, loaded with ballast, and surmounted with a concrete superstructure of very heavy blocks, rising about three feet above the level of the highest tides.

The inner breakwater or jettee should be constructed simply with a grillage and loose stone, with perhaps a light superstructure of concrete.

The end and face of Galveston Island, if necessary, can be protected with facines or brush, ballasted.

No estimate is submitted, it being my purpose simply to submit the plan on such merit as there may be in its conception.

The plan for deepening the inner bar by prolonging the head of Galveston Island to the "Middle Ground Breakers" was suggested by Lieutenant W. H. Stevens, United States Engineers, in a report dated September 30, 1853, which will be found in vol. 2, pages 559, 560, Senate Document, first session Thirty-third Congress. Its execution was attempted in 1870 by Mr. Fowler, of Galveston, but with an insufficient amount of money, and by putting in a frail structure, consisting of rows of piles. Work on this was stopped before it had been extended far enough to give marked and indisputable results, or to warrant any other conclusion than the one I have given, as to what it would have done properly built and completed. It is now being rapidly washed away, the currents undermining it and storms sweeping it off. Its fate only serves to establish the fact, if such further evidence were needed, that the currents acting on the head of Galveston Island have great eroding effect.

In conclusion, I beg leave to express the opinion that dredging the inner bar at the entrance to this harbor will prove but a partial and temporary relief to the commerce of the port of Galveston.

Temporary, because the channel excavated will be subject to continual refilling, generally a slow but sure process, at times rapid. Partial, because not satisfying the demand for a channel admitting to the harbor vessels drawing more than 12 feet.

The rapidly growing State of Texas, with her developing capacity for producing material for export, should have, at least, one harbor on her coast that will admit vessels drawing 18 feet or more. Without that her commerce will be cramped and dependent on long lines of railway to connect it with distant ports.

That at Galveston, if not the best harbor on the Texas coast, is certainly the most central, (leaving out of consideration the barren northwestern portion of the State.) It is also in my opinion the harbor most susceptible of permanent improvement, to meet the full requirements of commerce, as I have become satisfied from the results of surveys recently made under my direction.

These surveys were made with a view toward attempting works for the improvement of the entrance to several harbors on the Texas coast. Works have been suggested for each, involving great expense in their construction, and confessedly of doubtful efficacy after completion.

The views of the engineers making reports on these surveys at Pass Cavallo, Aransas Pass, Corpus Christi Pass, and Brazos San Jago, are in harmony with those expressed by officers who made surveys of the same passes for the same purpose in 1853-'54.

Under the circumstances, I think it proper to recommend that only the harbor of Galveston be selected for improvement, and such driblets of appropriation as might otherwise be wasted on other Texas harbors be consolidated, to inaugurate a permanent and valuable work at Galveston.

With these remarks, I have the honor of closing my report on improvements in my charge.

And subscribe myself, very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, United States Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Draft of an act of Congress.

AN ACT entitled an act to facilitate the execution of, and to protect certain public works of improvement.

Whereas, in the prosecution of certain works of river and harbor improvement, undertaken by the Government of the United States, and involving the dredging of river or tidal bars, the engineers charged with the work meet with frequent delay, and the channels excavated with important damage, due to the passage of vessels at unseasonable times, and to the careless or malicious handling of the same: And whereas this occurs only because there is no one person duly authorized to superintend and direct the passage of vessels, and to hold pilots, ship-masters, and tow-boat captains responsible under a penalty for damage they,may cause such public works described: *Be it therefore enacted, &c.,* That from and after this date the Secretary of War is authorized to assume full control over the navigation of channels in course of excavation across bars at the mouths of rivers or entrance to harbors, whenever and wherever, in his opinion, such action becomes necessary to facilitate and protect the work of the Government, and that such regulations regarding the passage of vessels through such channels as he may establish shall have binding effect on all pilots, ship-masters, tug-boat captains, and other persons seeking the use of such channels.

Be it further enacted, That, for all violations of such regulations, the Secretary of War shall be competent to assess a fine of not less than $50 nor more than $500, the same to be recoverable in the United States circuit court for the district in which the channel may be located, and shall further have power to deny the person or persons offending the privilege of conducting their business through such channel for such period, not to exceed one year, as may, in his opinion, appear equitable and conducive to the interests of the Government and of commerce.

Proposals for the improvement of the inner bar at entrance to Galveston Harbor, Texas.

Proposals for executing the above-named work of improvement, in accordance with plans and specifications on file in this office, will be received by the undersigned until the 31st day of January, 1871. The work will consist in dredging a channel 80 feet wide, 12 feet in depth at mean low tide, for that width through the sand deposit forming the bar named.

Proposals will be for opening such channel within a specified time, and for afterward keeping it open one year.

The amount of deposit to be removed, as measured in the bar December 15, 1870, is 6,794 cubic yards. The deposit excavated must be removed in scows for dumping to a point hereafter to be determined by the engineer in charge, the distance of transfer not to exceed three miles—$23,000 is available for the work.

The terms of payment will be one-quarter of contract price on completion of the channel, one-quarter after the channel shall have been continuously kept open to the full depth and width specified for four months, one-quarter in eight months, the remaining one-quarter on the completion of the contract, in accordance with the strict terms of agreement. In making bids, the usual rules relating thereto must be strictly observed.

C. W. HOWELL,
Captain of Engineers, United States Army.

UNITED STATES ENGINEER OFFICE,
New Orleans, No. 23 Rampart street, December 19, 1870.
(Address Lock-box 950.)

Proposals for opening the inner bar at entrance to Galveston Harbor, Texas.

NEW ORLEANS, *January* 31, 1871.

SIR: We propose to deepen the inner bar at Galveston Harbor to 80 feet wide and 12 feet deep for $21,750, to commence within six months, or as soon as we can build suitable machinery. We will open it on or before three months from time of commencement.

Your obedient servant,

E. B. BISHOP.

Captain C. W. HOWELL,
Engineer United States Army.

NEW ORLEANS, *January* 31, 1871.

SIR: After we have opened the inner bar at Galveston to 80 feet wide and 12 feet deep, propose to keep it same depth and width for $4,900 per month for twelve months.

I have the honor to be, your obedient servant,

E. B. BISHOP.

Captain C. W. HOWELL,
Engineer United States Army.

NEW ORLEANS, *January* 27, 1871.

SIR: In compliance with the specifications embraced in your advertisement for proposals for the improvement of the inner bar at the entrance of Galveston Harbor, I propose to do the said work and keep it open, for the term of one year, for the sum of $14,000, and to accomplish the work by substituting my own apparatus in lieu of dredging.

Please find inclosed herewith a copy of specifications and plan of apparatus.

Yours, very respectfully,

JOHN HALLIDAY,
Civil Engineer.

C. W. HOWELL,
Captain Engineers, U. S. A.

This agreement, made and entered into the sixteenth day of May, in the year one thousand eight hundred and seventy-one, between Augustus T. Morris and James Cummings, composing the firm of Morris & Cummings, of the city of New York, parties of the first part, and C. W. Howell, captain of engineers, of the city of New Orleans, party of the second part, witnesseth: That in consideration of the sum of one dollar, to them in hand paid by the said party of the second part, the receipt whereof is hereby acknowledged, the said parties of the first part agree to build a first-class dredging-machine, capable of excavating one thousand cubic yards of mud in a day of ten hours, the said machine to be provided with one double engine of suitable power, boiler of proper size for serving engine, and a bucket of the capacity of one and a half cubic yards, together with all the necessary machinery and apparatus to work the same; the hull of said machine to be of the same dimensions as the hull of the dredge now working for the Mississippi and Mexican Gulf Ship Canal Company, at the city of New Orleans, say about sixty-five feet in length, thirty feet in width, and nine feet in depth, to be built in a strong and substantial manner, and to be fitted and sheathed; the said machine to be delivered to the party of the second part, at the city of Galveston, Texas, in about one hundred working days from the date of this agreement. And the said party of the second part, upon the performance by the parties of the first of all the stipulations entered into by them, as herein set forth, hereby agrees to purchase from them the said dredging-machine, and to pay therefor the sum of twenty-five thousand dollars, payable in United States Treasury notes, upon the delivery of the said machine at the city of Galveston, as aforesaid.

In witness whereof the parties to these presents have hereunto set their hands and seals, the day and year first above written.

(Signed in triplicate.)

MORRIS & CUMMINGS. [SEAL.]
C. H. HOWELL, [SEAL.]
Captain of Engineers, U. S. A.

Sealed and delivered in presence of—
WM. CAMPBELL.

N 2.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., February 8, 1871.

SIR: The communication from the Committee on Commerce of the Senate, referred to this office, inclosing a resolution of the Senate of the 14th December last, instructing that committee to inquire into the expediency of constructing a canal from the Mississippi River, near Fort St. Philip, to a point near Bréton Island, in the Gulf of Mexico, is herewith respectfully returned, and I also transmit a report from Captain C. W. Howell, Corps of Engineers, in charge of the improvement of the mouth of the Mississippi, to whom the subject of this resolution was referred.

The information in the possession of this office in regard to this project indicates the practicability of constructing and maintaining such a canal, but it does not admit of the preparation of a project with estimate of cost. It has had for years past many advocates and opponents. In 1837, Major Chase, Corps of Engineers, prepared a careful estimate of its cost, upon a plan originating with Major Buisson, of New Orleans. He concluded that a canal 100 feet at surface and 30 feet deep would cost, all accessory works included, $10,000,000. Colonel Crozet, about the same time, advised a reduction of the depth to 20 feet, and believed that the cost would not then much exceed five million. Mr. Montaign, in a memoir upon the subject, printed in New Orleans in 1869, puts down the cost at $2,600,000, a sum beyond question entirely too low.

Assuming the whole cost at $10,000,000—and it will probably not fall short of that sum—the yearly interest of this would be more than double the cost of maintaining two such dredge-boats as the one now successfully operating at the Southwest Pass, in constant work during the year, and insure a continued depth of 20 feet over the bar.

Still, the project of a canal is one which deserves careful examination. I would, therefore, suggest an appropriation of $10,000 for the purpose of making careful investigation of all questions bearing upon its location and construction and estimates of its probable cost.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

N 3.

UNITED STATES ENGINEER OFFICE,
New Orleans, February 9, 1871.

GENERAL: In obedience to telegraphic orders of February 3, I have to render this preliminary report of an examination made from the mouth of Bayou St. John, Louisiana, through Lake Pontchartrain and the Rigolets, to Ship Island.

The line along which examination was directed is that proposed by the New Orleans and Ship Island Canal Company for the location of a ship-canal. The examination was made with a view to ascertaining the feasibility of this canal project.

It was only considered necessary to determine the following, viz:

1st. The depth of water along the route indicated; 2d. The nature of the bottom and sub-strata where excavation would be required; and 3d. The probable action, on the bottom, of winds, tides, and storms.

1st. The first was ascertained by verifying the soundings exhibited on existing charts of the line, as well as it could be done while passing over the line in a steamer and employing an ordinary sounding-lead. The results are shown on a tracing submitted herewith.

2d. From the mouth of Bayou St. John to the head of the Rigolets the bottom was found to be composed of a very soft mud, that over the middle ground being of the lightest quality of alluvial deposit. The great depth of the Rigolet made it unnecessary to determine the nature of its bottom. The middle ground at the mouth of the Rigolet, (opposite the mouth of Pearl River,) extending to the tide-bore at St. Joseph's Island, is of the same material as the upper middle ground. The bottom of the tide-bore named is of stiff clay and sand. Passing St. Joseph's Island, there is found a large shoal produced by the tide-currents through Mississippi Sound, Cat Island Pass, the St. Joseph tide-bore, and the entrance to Lake Borgne; its surface material is varied in character, being of light sand, and a deposit similar to that observed on the middle grounds, but more sticky and compact. The sand is found fringing the northern, eastern, and southern edges of the shoal, forming a hard bottom about 18 inches in thickness, resting on soft mud, the same as is found in the center of the shoal. This fringe was found of but slight width at the points examined. Passing this, through Cat Island Pass, there was found sticky clay bottom, and the same was observed on the bar at the entrance to Cat Island Pass.

Along the whole line, at depths varying from 16 to 18 feet, was observed a stratum of clay and sand mixed, sticky and compact. The thickness of this stratum was not determined. As it underlies the deepest parts of the channels examined, it is shown to be at least from 12 to 14 feet thick.

3d. From the character of the bottom observed, the slight depth of water over the shoals, their exposed position, and the strong currents at times passing over them, it is inferred that their surfaces must be continually shifting. The sand-fringes observed on the outer shoal give evidence of a backward and forward movement of material across the shoal, and of a sorting of that material by the currents. The action of the tide-currents alone may be slight, but when aided by storms or high winds, particularly over the outer shoal, which is exposed from every quarter, the movement over the surface of the shoals must be very considerable. I did not have an opportunity to observe this on the line examined, but judge from having observed the effect of a strong northwest wind on a bottom of like material similarly exposed, (Poza Bay,) depth of water from 7 to 8 feet. The deposit was stirred up in such quantity as to discolor the water of the bay.

It is not to be inferred that other than comparatively slight and temporary changes may be effected in the form or location of the shoals or in the depth of water over them, for I have good evidence that for a very long period no appreciable permanent changes have taken place, particularly in the depth of water. What I infer is that but little first deposit is being added, and that the tendency of the tide-currents is to simply level the deposit on the shoals by moving it back and forth, (not to carry it away,) maintaining a constant cross-section of water-way. However much storms, muds, or the hand of man may change this, the tides will act continuously and effectively to restore the normal condition; in other words, if excavation is made, it will be filled; if ridges are formed, they will be leveled.

I have styled this a preliminary report, because, although I consider the results of my first examination conclusive, I yet wish to multiply the number of borings along the line examined, and make more exact observations as to the thickness of the several strata found.

When a second examination is made, I will forward the information gained as an addendum to this report.

I take pleasure in acknowledging the courtesy of Captain Davis, of the United States revenue-cutter Wilderness, who afforded me many facilities for making this examination.

In conclusion, I have the honor to be, very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

N 4.

UNITED STATES ENGINEER OFFICE,
New Orleans, Louisiana, May 2, 1871.

GENERAL: I have the honor to forward herewith a report made by First Lieutenant E. A. Woodruff, Corps of Engineers, United States Army, after a careful survey and examination at Corpus Christi and Aransas Passes, opening from Corpus Christi Bay and Harbor, Texas, and at Pass Cavallo, the entrance to Indianola Harbor, Texas. These surveys were made in compliance with instructions dated Office of the Chief of Engineers, Washington, D. C., July 23, 1870.

Lieutenant Woodruff presents plans for improving the entrance to Corpus Christi Harbor through Aransas Pass, and estimates the cost of carrying them out, but does not recommend that the work be undertaken.

No attempt to improve the two other passes is recommended.

I coincide with Lieutenant Woodruff in the opinion that all the plans suggested and discussed by him offer no certainty of producing good results, and that the expense which will be incurred by testing them will be out of all proportion to the benefits derivable from success.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, Louisiana, April 1, 1871.

SIR: I have the honor to report that I have complied with your instructions, dated at this office, February 7, 1871, directing me "to make examination and surveys of the bars at the entrance to Pass Cavallo, Aransas Pass, and Corpus Christi Pass, on the coast of Texas, for the purpose of collecting all information needed to form plans and estimates for such works of improvement as I may recommend be undertaken by the General Government to deepen the channel across the bars at the entrance of these passes."

I submit the following report concerning each of the harbors mentioned, beginning with that of Corpus Christi:

Corpus Christi Pass or Inlet is an entrance from the Gulf of Mexico to Corpus Christi

Bay, between Mustang Island on the north and Padre Island on the south, in the collection district of Corpus Christi. The channel from the pass to Corpus Christi Bay is narrow, and bears in general direction nearly due north about six miles before reaching the deep water of the bay. Entering the pass from the Gulf, we find the water on the bar from 5 to 7 feet deep, varying with wind and tide. In the middle of the channel, at its mouth, are two sand islands, the lower of which extends at low tide to the coast line. These islands form a sand ridge, dividing the channel nearly equally for about two miles up from the coast line, where on the left we find a series of mud flats and low islands obstructing the entrance to Laguna del Madre. The south and deeper channel through the bar continues along the shore of Padre Island, gradually shoaling till lost in these mud flats, while the north and shallower channel is found near the shore of Mustang Island, till its entrance into Corpus Christi Bay. No passage deeper than 6 feet was found between the north and south channels above the island at the mouth, but from a short distance above these islands the channel near Mustang Island has from 10 to 20 feet of water to within about a mile from the deep water of Corpus Christi Bay. Here the channel divides, the part near Mustang Island carrying 3 or 4 feet into the bay, while the part which continues north has deep water, (10 to 18 feet,) till it is closed by a sand flat called "the bulkhead." The end of this channel in the bulkhead is called "the pocket," in ascending which the water suddenly shoals from 18 feet to 8 feet, gradually shoaling thence to 2½ feet at low tide on the top of the bulkhead, whence it deepens gradually to the depth of the bay of Corpus Christi, 15 to 18 feet. The distance across the bulkhead from 8 feet in the pocket to 8 feet in Corpus Christi Bay at low tide is 2,400 feet, and the flat on the top of the bulkhead, where the water is 2½ feet deep, is about 900 feet. This channel is evidently the natural outlet of Corpus Christi Bay, but the gradual accumulation of shell, mud, and sand washed from Flour Bluff on the west and Mustang Island on the east, has closed it at the bulkhead, and the bar at the Gulf entrance prevents the safe entrance of vessels drawing over 5 feet. The length of the channel, six miles, from the bulkhead to Corpus Christi Pass, lessens the probability that a free passage of water from the bay would sufficiently deepen the pass through the bar, but the direction of the channel, the position and volume of Corpus Christi Bay, and the direction of prevailing winds, make it very probable that such passage would have a favorable influence in the improvement of the pass.

At best, however, although the shore lines show a pretty straight passage from the bulkhead to the bar, the deep-water channel is narrow and crooked, precluding the possibility of vessels of ordinary size, in the Gulf trade, beating between the Gulf and Corpus Christi Bay. The commerce which seeks Corpus Christi, owing to the facilities for inland communication with Mexico and the region between the Nueces River and the Rio Grande, is of considerable and increasing importance; and as Corpus Christi Bay is in every way the best on the coast, it seems very desirable to open a good channel between it and the Gulf. Aransas Pass, fifteen miles north of Corpus Christi Pass, seems as susceptible of improvement as any on this coast, and it is my opinion that a channel to allow the free passage of water from Corpus Christi Bay to Aransas Pass would improve that entrance and afford at the same time a permanent way for vessels to Corpus Christi Bay. The superiority of Aransas Pass to Corpus Christi Pass as an entrance from the Gulf is evident from an inspection of the maps accompanying this report. At present the commerce of Corpus Christi passes through Corpus Christi Bayou, a narrow and crooked passage, through mud flats north of Harbor Island, which separates Aransas from Corpus Christi Bay. This passage gives only four or five feet of water, and requires the use of lighters to transport freight from Aransas Pass to Corpus Christi.

The following statement, compiled by Dr. Thomas Kearney, collector of customs for the port of Corpus Christi, gives authentic information from which its importance may be judged: Total amount of duties collected, from organization of the district February 1, 1867, to May 1, 1870, $95,245; total expenses for same time, $40,670; total profit to United States, (gold,) $54,575.

Table showing the different ports in the customs district from which duty has been collected, during the term of the present collector, up to May 1, 1870, (eleven months and thirteen days,) and the amount collected from each.

Laredo, direct importation, specie	$15,156 27
Carrizo, direct importation, specie	2,020 87
Roma, direct importation, specie	7,865 99
Rio Grande City, direct importation, specie	11,116 18
Corpus Christi, withdrawn for consumption	8,085 99
Total	44,245 30
Total expenses for same time	16,170 00
Profit to United States, specie	28,075 30

Table showing value of merchandise, in bond, exported to Mexico from district of Corpus Christi, from 1st of January, 1868, to 24th of May, 1870; also value of merchandise which passed through respective ports.

Roma, value of merchandise	$44,139 00
Rio Grande City, value of merchandise	7,732 00
Laredo, value of merchandise	44,221 00
Total	96,092 00

Value of bonded goods which entered warehouse in customs district of Corpus Christi, from June 17, 1867, to May 24, 1870, $135,890.

Number and tonnage of vessels entered and cleared in customs district of Corpus Christi, from July 1, 1868, to May 1, 1870.

Entered: Number, 253; tonnage, 45,803.90.
Cleared: Number, 223; tonnage, 43,964.71.

Amount of produce and merchandise received and shipped at Corpus Christi, from 1st of January, 1869, to May 20, 1870, compiled from books of wharf agents.

Merchandise received: 69,500 pounds assorted; 2,081,447 feet of lumber; 1,585,475 shingles.

Produce shipped: Wool, 1,908,829 pounds; dry hides and skins, 2,220,953 pounds; tallow, 846,278 pounds; salt beef, 100,159 pounds; lard, 21,514 pounds; bones, 75,000 pounds; pig-lead, 340,651 pounds; rags, 2,381 pounds; horns, 5,198 pounds.

ARANSAS PASS.

By a comparison of the Coast Survey maps of 1853, 1868, and the map herewith submitted, February, 1871, it is seen that the channel is constantly encroaching on Mustang Island, (on the south,) while St. Joseph Island is accumulating, and making out with a low sand flat, with shoal water at considerable distance from the shore-line. In 1853 the channel through the bar was parallel to its present position, but farther north. In 1868 it was about perpendicular to its present position. In 1869 a work was begun by private enterprise, to improve the channel through the bar by running out lines of jettees from the St. Joseph Island shore, to cut off a secondary channel near this shore. These jettees, crates, or caissons, as they are variously called by the builders, were made of live-oak poles, spiked together in the general form of a triangular prism, and placed longitudinally. Each crate was about 8 or 10 feet long, 6 feet high, and 6 feet wide at the base, resembling, when in position, the roof of a house, with only rafters in place. These crates were ballasted with a few hundred-weight of stone, filled with brush, and sunk in two or three parallel rows, in the position described. They were expected to act as a nucleus, about which sand would settle, and close up the secondary channel, thus directing the flow of the water directly through the channel in the bar. From the fact that the secondary channel has shoaled about 2 feet, and the main channel deepened about 2 feet since placing the crates, it may be supposed that they have contributed to produce this result, but one of the oldest pilots holds that the change is due to storms, and would have taken place without any work. Owing to the constant erosion of Mustang Island, and consequent shifting of the pass to the south, in a few years the jettees mentioned will have no effect on the current, being left on St. Joseph's Island, which follows the channel in its progress south. It seems probable that the channel must continue to shoal, unless the erosion of Mustang Island, and consequent shifting and widening of the channel, can be prevented. The scour is at least 36 feet deep; hence any attempt to protect Mustang Island by a revetment would be expensive, requiring piles at least 45 feet in length, if a pile revetment were attempted. As any plan for deepening the channel through the bar by the action of the current must require the protection of Mustang Island against the encroachment of the channel, before attempting jettees or piers from the Gulf-shore line toward the bar, the means of affording such protection is the first question for consideration. Turtle Cove affords no passage over a foot in depth to Corpus Christi Bay; hence there is no current of importance at its mouth. The present entrance to Corpus Christi Bay is through Corpus Christi Bayou, a crooked channel of scant 5 feet of water, which enters Aransas Bay about ten miles from Aransas Pass. A canal 150 feet wide and 12 feet deep, from the mouth of Turtle Cove due west to Corpus Christi Bay, would allow sailing-vessels to pass in either direction at almost all times with the prevailing winds, thus opening the best bay on the Gulf as a harbor for vessels which could enter Aransas Pass. It is probable that such a canal would have a current of sufficient power to modify the action of the channel-current on Mustang Island, checking, and perhaps stopping, the erosion for some distance below the mouth of Turtle Cove. Harbor Island, on which the light-house is situated, and through which this canal is proposed, is flat and marshy, composed principally of shell-mud. The mouth of Turtle Cove has a sandy bottom, a part of the sand deposit which extends in front of the light-house. A revetment to the north side of such a canal, extending from the shore of Harbor Island to the 12-foot curve in the channel, would serve the double purpose of protecting the mouth of the canal from the sand-deposit above, and acting as a wing-dam to deflect the current of the ebb-tide from Mustang Island. To direct the current of ebb-tides from the pass constantly through the same part of the bar, it will be necessary to shield this current from the action of the littoral current. The littoral current varies with the wind, and, according to the testimony of pilots, its direction is up the coast when the wind is south of southeast, and down when the wind is north of that quarter. They agree in stating that the direction of this current is up the coast during the greater part of the year. Its maximum rate is variously estimated at from one to two miles per hour. To protect the ebb-current of the channel from the action of the littoral current until the former reaches the bar, would require at least one jettee or pier extending from the shore-line to the bar, a distance of about 4,800 feet. Of this distance about 2,000 feet would be in water less than 12 feet deep. The remaining 2,800 feet would be in water 12 to 18 feet deep. The first 2,000 feet would probably produce a perceptible effect on the bar, but the extension of the deep water of the channel across the bar could not be expected unless the jettee were carried across it to deep water outside. A gradual extension of either or both island shores toward the Gulf could probably be effected by a system of groins or works similar to the rows of crates mentioned as having been placed on the end of St. Joseph's Island, but the bar would probably keep pace with such shore-line extension in its progress outward. Even if the 4,800 feet of jettee could be built at once, it is possible that a few years would suffice to extend the shore-line so that a sand-deposit might be expected near the end of the jettee where the channel-current would be exposed to the full effect of the waves and the littoral current. It would not be safe to attempt any jettee from Mustang Island toward the bar before securing the end of this island from further encroachment of the channel, and any attempt to narrow the channel from the side of St. Joseph's Island would only increase the action of the current on Mustang Island, probably without producing any beneficial effect on the bar. I submit two plans, with estimates of cost of each, for the protection of Mustang Island, from the mouth of Turtle Cove to the shore-line of the Gulf. The distance is 1,550 yards.

First. A series of groins or pile-work at points shown on the map, normal to the shore-line; the groins being built to present a concave front to the current, whether at ebb or flood tide; each groin to be 100 feet in length, measured perpendicularly from its base, which is 200 feet in length on the shore; the sides of each groin to be formed on an arc, with radius of 100 feet; these arcs being tangent to each other at the point of the groin, and also tangent to the base of the groin at the ends of the base; the interior of the groin to be filled with brush and stone, and the outside near the point to be riprapped with stone.

Stone of a sufficiently good quality for this purpose can be had at Rockport, about twelve miles distant. I was told by prominent citizens that the expense of delivering it at the pass would not exceed $10 per cord.

Estimate of cost of one groin, as described.

566 piles, average length 24 feet, cost each $6	$3,396 00
Driving 566 piles, at $2 per pile	1,132 00
Cutting off and capping same, at 50 cents each	283 00
200 cords of stone, at $10 per cord	2,000 00
100 cords of brush, at $2 per cord	200 00
700 drift-bolts or spikes, 350 pounds, at 7 cents	24 50
200 screw-bolts, 1 inch diameter, 12 inches long, with washers, 1,000 pounds, at 8 cents per pound	80 00
3,684 feet (board measure) pine plank, at $30 per M	110 52
Total	7,226 02
Cost of four similar groins	28,904 08
Add 10 per cent. for contingencies	2,890 40
Total	31,794 48

Second. A system of riprap extending from near the mouth of Turtle Cove to the Gulf-coast line, a distance of 4,500 feet.

Estimating for one cord of stone to each foot of shore-line:

4,500 cords of stone, at $10	$45,000 00
Add 10 per cent	4,500 00
	49,500 00

Estimate for a canal from the mouth of Turtle Cove, due west, (true,) to Corpus Christi Bay; dimensions 150 *feet wide at bottom,* 10 *feet deep at mean low water, four miles long.*

As Harbor Island is barely out of water at ordinary high water, and the proposed direction of the canal is through extensive mud-flats covered with water, the estimate may be safely made on the supposition that there is no excavation above mean low water.

Cost of excavating 1,251,555 cubic yards, at 50 cents per cubic yard	$625,777 50
Add 10 per cent	62,577 75
Total	688,355 25

Second. To form a base for a system of ripraps by building of palm, palmetto, cabbage, or mangrove, triangular prisms 10 feet long, 6 feet on each side, with cross-pieces 12 feet in length, bolted to base, one at each end. These prisms filled with stone and placed parallel to the shore-line in 5 feet of water, with stone filled in behind to high-water mark. This system to extend from near the mouth of Turtle Cove to the Gulf-coast line, a distance of 4,500 feet.

Cost of timber for each prism	$50 00
Cost of making and placing	50 00
	100 00
450 prisms, at $100 each	45,000 00
One cord of stone to each linear foot, at $10	45,000 00
	90,000 00
Add 10 per cent. for contingencies	9,000 00
	99,000 00

Estimate of cost of revetment or jettee at north side of entrance of canal, at mouth of Turtle Cove, as indicated on map; 1,400 *feet long,* 10 *feet wide.*

1,420 piles, average length 25 feet, at 25 cents per linear foot	$8,825 00
1,400 piles, average length 15 feet, at 25 cents per linear foot	5,250 00
Driving 2,820 piles, at $2 each	5,640 00
140 cross-ties, 8 by 10 inches by 10 feet, 9,333⅓ feet, board measure, at $30 per M.	280 00
2,820 linear feet wall-timber 8, by 10 inches, 18,800 feet, board measure, at $30 per M.	564 00
1,000 screw-bolts, 18 inches long, 1 inch diameter, with washers, 6,000 pounds, at 8 cents per pound	480 00
Cutting off and capping piles, at 50 cents each	1,410 00
Filling brush, 1,000 cords, at $2 per cord	2,000 00
Stone, 400 cords, at $10	4,000 00
	28,449 00
Add 10 per cent.	2,844 90
Total	31,293 90

The cost of building a jettee from Mustang or St. Joseph's Island toward the bar, which would be able to resist the action of the storms upon the quicksand foundation, must be an insurmountable objection to any such experiment. The stone to be obtained at Rockport is too poor in quality for use in so exposed a work. Such a pier, if built in the shoal water on either side of the present channel, would be exposed to a change in the depth of the water on the channel side, which would be fatal to any work whose foundations were not below the scour.

Pile-driving would be very expensive, owing to the exposed situation, indeed hardly practicable; and the presence of the *teredo navalis* prevents the use of any timber suitable for making crib-piers. No estimate for such a work is presented. The above estimates are made to show the cost of a beginning of any harbor improvement on this coast. Whether the necessities of commerce demand such extensive outlays or not, is a question which has been answered negatively by former reports on the subject.

The commerce of this region has increased rapidly since the war, and the city of Rockport, which has been built entirely within the past four years, has now a population of about 1,500.

Rockport is situated north of Corpus Christi Bayou, on Aransas Bay, about twelve miles from Aransas Pass. Its wharves are protected from north winds by Nine-Mile Point, but are exposed to easterly winds. It is in the collection district of Corpus Christi, and is the point for the reshipment of freight for that place.

The following list of exports and imports of Rockport for the year ending March 1, 1870, is compiled from the books of the wharf company:

Exports.—Wool, pounds, 973,165; hides, wet salt, number 39,207; tierces of beef, 1,481; barrels of tallow, 2,882; tierces of lard, 35; number of calves, 3,119; number of sheep, 1,866; empty beer-kegs, 233; hogsheads dried beef, 23; bales of cotton, 29; kegs of lead ore, 4; pounds of dry hides in bales, 108,633; number of loose dry hides, 9,950; barrels of beef, 1,564; hogsheads of tallow, 556; number of beeves, 7,441; number of horses, 596; number of hogs, 1,547; boxes merchandise, 71; boxes beef, 84; bales of rags, 16; half barrels of beef, 37; coin, $15,442.

Imports.—Assorted merchandise, per steamship from New Orleans, 145,782 barrels.

PASSO CAVALLO.

Passo Cavallo, the entrance to Matagorda Bay, is situated in the collection district of Saluria, between Matagorda Island on the south and Matagorda Peninsula on the north. It presents the same general characteristics as Aransas Pass, but on a much larger scale. Its history, like that of Aransas and Corpus Christi Passes, shows a steady deterioration as a harbor, and a constant shifting of the channel to the south. The constant shifting to the south of these three channels, which is a well-established fact, indicates some general cause for such change; and the historical fact of the deterioration of these harbors in the same time leads to the inference that the shoaling is due to the change in position. The general cause for the change is probably the prevalent direction of the winds, which have the greatest effect on the southern shores of the passes. The most rapid erosion has taken place during high tides accompanied by easterly winds. In August, 1868, a violent storm of this description swept away the whole east parapet of Fort Esperanza, an earth-work revetted with turf, situated on Matagorda Island, about-half way between the light-house and Bayou McHenry. The parapet was about 9 feet high, and when built, during the war, was about 100 feet from the shore. In 1854 a remarkable storm occurred, which reduced Pelican Island to a mere sand flat, hardly above ordinary high water. Before this storm it had grass-covered sand mounds, about 20 feet high, and fresh water could be obtained by digging in the hollows. The storm began by a southeaster, which filled Matagorda and Espiritu Santo Bays unusually full of water; then, changing to the northwest, the wind drove the water of the bays through the channel and over the end of Matagorda Island and Peninsula. The direction of the channel was changed considerably to the south, and its depth increased to 13 feet, but it shoaled to 8 feet in 1856, and at present 7 feet is all that can be depended upon, although vessels drawing 8½ feet enter by waiting for a very favorable tide. In the storm of 1854 four vessels were blown from their anchorage near Decrow's Point, and lost or wrecked on the point; but in ordinary storms there is good anchorage from opposite Pelican Island to the bay north of Decrow's Point. Beside the channel between Decrow's Point and Pelican Island, there is one much larger between Pelican Island and the shoal opposite the light-house. This channel at present is almost equal to the one generally used below the light-house, having at good tides about 7 feet of water, and a breadth of about 1,500 feet. Every storm, however, changes the position of the system of shoals running south from Decrow's Point. A line drawn from the extremity of Decrow's Point to the light-house passes through a channel on the north of Pelican Island, 23 feet deep and about 400 feet wide, and the average depth of the whole channel north of Pelican Island, on this line, is 9 feet. The coast survey of 1856 gives but 12 feet north of Pelican Island, on the same line, with an average depth of 6 feet. Changes equally marked may be seen on the south side of the island. Pelican Island itself has shifted its position to the north about three-fourths of a mile since the survey of 1856. Vessels, once inside of the bar, can carry 24 feet to the anchorage, north of Decrow's Point; 12 feet to opposite Alligator Head, and about 9 feet to the wharf at Indianola, formerly called Powderhorn, now the principal town on Matagorda Bay.

I found an idea generally prevailing among the citizens interested in the improvement of the pass, that it would be easy to stop up the channel between Decrow's Point and Pelican Island, thus causing a greater current at ebb-tide to act on the bar. Decrow's Point, and a portion of Matagorda Island opposite, are low and subject to overflow in extreme high water. This is especially the case with Matagorda Island, where the salt water has killed the grass on about half the surface. In planting a signal-pole on this island, I found that, after getting through a crust of a few inches on the surface, I could easily thrust the whole pole, 8 feet in length, into the earth.

The effect of any work closing Pelican Island channel would be much more perceptible on Matagorda Island than on the bar, which at present is about three-fourths of a mile from the shore-line of the Gulf; and any attempt to narrow the outlet of Matagorda Bay, without first protecting Matagorda Island by an efficient revetment, would be a waste of the money expended. Any plan for removing the bar by the action of an ebb-current must fail, unless the direction of the current is controlled and the force preserved till it is brought to bear directly against the obstacle. This would require a jettee from Decrow's Point to the bar, a distance of four miles, and a revetment of Matagorda Island from Bayou McHenry to the point below the light-house, also a distance of four miles. Both of these works would be principally on quicksand foundations, and both, especially the jettee, would be exposed to seas which only a massive sea-wall could permanently resist. Small works, such as pile groins or piers, will succeed in causing an accretion of sand during the continuance of ordinary tides and weather; but a high tide with strong winds will, in a few hours, sweep away the accretion of months, and the work which caused it. Such has actually been the history of some small pile-works attempted on the Matagorda Island shore. A permanent sea-wall or a solid pier of any kind, four miles in length, able to withstand the storms of a single year at the point, would require the expenditure of millions. Any system of dredging for deepening the water on the bar would require a constant outlay, for any channel deepened in this manner would fill up at the first moderate breeze. However, a fraction of the interest on the sum required to make a permanent channel by jettees and revetments would keep several dredges at work if weather would permit.

The pilots say that the water outside of the bar is not smooth enough for loading vessels, with lighters, more than one-fourth of the time. Such loading, at this point, is rarely if ever attempted. These facts preclude the idea of deepening the channel on the bar by the use of any ordinary dredge. In speaking of the current of the passes, I have called it the "ebb-tide," for, although rivers empty into the bays, and have their ultimate outlet at the passes, the tidal current only is perceptible, flowing as rapidly in one direction as in the other. The extent of the bays and the effect of the wind completely obliterate the action of the fresh-water streams, as far as ordinary observations are concerned. That the ebb-current does deepen the passes through the bars, is shown by the fact that they are deepest in the latter part of winter, after the action of the northers, which generally blow after a full tide in the bays, caused by violent southeast winds.

Concerning the practicability of improving either of the harbors in question, I beg leave to quote from the report of Captain G. B. McClellan to Brevet Brigadier General J. G. Totten, Chief Engineer, U. S. A., Ex. Doc., vol. 2, 1853-'54, page 561:

* * * "I regard it as impossible to improve any of them (the bars on the Texas coast) by dredging, scraping, or any similar means; for, supposing that means may be found to overcome the difficulty of working under such circumstances, and that the channel were actually deepened to the required extent, it is certain that the same causes, which now operate in so constantly shifting the position of the channel, would almost immediately fill up any new one made by artificial means. It now remains to be considered whether it is possible to improve the bars by contracting or changing the direction of the channel by means of dikes, jettees, &c. The passes at * * Corpus Christi and Aransas, have each but a single outlet, all exceedingly narrow, and none admitting any further decrease in width. The only possible application of dikes in these cases would be to prolong the walls of the outlet until they reached a point very near the present position of the bar, in order to concentrate upon one spot the whole action of whatever outward current there might be. The ultimate effect of this would undoubtedly be the formation of a new bar outside; that, too, at no distant period. The immediate effect would by no means certainly be favorable, and the new outlet would be liable to be closed up by heavy storms, (subject to breaking out again,) as is now frequently the case with small inlets on the coast of Florida. With regard to the project of improving Pass Cavallo, by closing the Pelican Island channel, to which my attention has been called by the Department, I have, since my letter of January 13, given it an attentive consideration. Were the proposed dike constructed, the situation of affairs would be analogous to that now existing at the other passes; and I see no reason for believing that the strength of the new current would be much, if at all, greater than at Aransas or Corpus Christi Pass. Were the strength of the current increased, it would exert itself in cutting away more rapidly the point

of Matagorda Island, where the light-house now stands, and thus enable itself to spread out still more than it now does before reaching the bar. So far as it is possible to foresee the effect of so uncertain an operation, and judging principally from what I have observed at the passes in general, I think that, were any appreciable effect produced by closing the opening in question, it would be lateral rather than vertical. As regards the 20-foot channel expected to be obtained, one of 100 feet might be looked for with equal confidence. I therefore give it as my opinion that it is not advisable to attempt any improvement of the bars mentioned in this report, as such attempts would, in all probability, result in a very great waste of money and time, without any reasonable prospect of effecting any improvement. I will close this subject by stating that, in every instance, the foundation of any structure attempted would be in quicksand, and that the difficulties of construction would be very great. Were anything attempted at Pass Cavallo, beyond closing the Pelican Island channel, it would involve the revetment of about four miles of shore, and the construction of more than five miles of dike."

From Dr. J. K. McCreary, collector of customs of the district of Saluria, I obtain the following statement in regard to the commerce of this port:

Entrances.—Number, 248; tonnage, 165,994.97.

Clearances.—Number, 252; tonnage, 165,131.45.

Exports of Cattle.—Beeves, 32,877; yearlings, 4,412; sheep, 2,286; hogs, 288; horses, 6.

Other statistics in regard to the commerce of the port were collected from merchants and wharf company, and sent to me for this port, but have not yet been received.

Indianola is the terminus of a railroad projected from San Antonio, and now finished to Victoria, forty miles distant. In size and importance it is second to Galveston on the coast of this State.

I remain, very respectfully, your obedient servant,

E. A. WOODRUFF,
First Lieutenant, U. S. Engineers.

Captain C. W. HOWELL,
Corps of Engineers, U. S. A., New Orleans, La.

N 5.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., April 4, 1871.

GENERAL: I have the honor to report that, in obedience to instructions contained in Engineer Department letter, dated July 23, 1870, I have caused to be made a survey and examination, at Buffalo Bayou for a channel of navigation through Buffalo Bayou and Galveston Bay to Bolivar Channel, near the outer bar in the Gulf of Mexico.

I forward herewith the report of First Lieutenant H. M. Adams, Corps of Engineers, United States Army, who was charged with the conduct of the survey; also the maps to which he refers in his report.

The recommendation made by Lieutenant Adams is concurred in, so far as relates to the excavation of a six-foot channel across Red Fish Bar and Clopper's Bar, 100 feet in width. Estimated expense, $62,805.

It should be remarked that this estimate contemplates having the work done by contract, at 50 cents per cubic yard. Should the work be authorized by Congress, the engineer placed in charge may find himself forced to purchase dredges, scows, and lugs with which to prosecute it; thus involving greater expense than estimated. In view of this contingency, I think it advisable to increase the estimate to $125,000.

There will further be required an annual appropriation (the amount of which may not now be estimated) for maintenance of channel.

Before the United States Government assumes charge of this work, the right of the Houston Direct Navigation Company to collect tolls on vessels going no farther up the bayou than Harrisburgh, should be extinguished, after reimbursing this company for money they may have expended in making valuable improvements below Harrisburgh.

The work is situated in the collection district of Galveston, between the ports of Galveston and Houston, and near the light-houses on Red Fish Bar and Clopper's Bar, Galveston Bay, Texas.

I have the honor to be, very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., December 6, 1870.

SIR: You are hereby directed to take charge of the following-named surveys and examinations, viz: * * * * * * *

3d. An examination of Buffalo Bayou, Texas, to be made with a view to its future improvement by removal of obstructions to navigation. This examination will extend from the mouth of the bayou to the highest navigable point on the stream.

You will be required to ascertain the nature and location of all obstructions, estimate the probable expense of removing them, state the kind and amount of commerce dependent on navigation of the bayou, the class and number of vessels now employed in it, the probable advantage which will arise from improvement of its navigation, and report a plan for such improvement as you may recommend.

A written report, embodying all information obtained, plan and estimate, is directed to be accompanied by a sketch giving such particulars as can be best shown in that manner. * * * * * * * *

The manner of conducting these works is left to your own judgment. Complete information on all points connected with them, and economy in expenditure of moneys appropriated for carrying them on, are desirable.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

First Lieutenant H. M. ADAMS,
Corps of Engineers, U. S. A., New Orleans, La.

NEW ORLEANS, LOUISIANA, *March* 3, 1870.

SIR: I have the honor to report that, in compliance with the foregoing instructions contained in your letter dated December 6, 1870, the examination of Buffalo Bayou was commenced December 16, 1870, and finished January 6, 1871.

DESCRIPTION OF THE BAYOU.

Buffalo Bayou is a tide-water stream emptying into the San Jacinto River at Lynchburgh, about eight miles from the junction of the latter stream with Galveston Bay. The bayou is navigable for vessels drawing less than 4 feet to Houston, about twenty-five miles above Lynchburgh. It is not navigable above Houston. At this point steamers are able to turn, which they are not able to do for about five miles below Houston, on account of the narrowness of the stream.

OBSTRUCTIONS TO NAVIGATION.

The only obstruction to navigation by vessels now employed in the Buffalo Bayou trade or to vessels of deeper draught, arises from the nature of the bayou itself between Harrisburgh and Houston, where it is both narrow and shallow, the least depth of channel being 4 feet and the least width 70 feet. The banks of the bayou for five and a half miles below Houston are high, in some places 45 feet above the surface of the water, but generally about 15 or 20 feet, and are composed of sand, loam, and red clay. The course of the stream between Harrisburgh and Houston is very circuitous and the bends are sharp. Some twenty years ago the bayou was much deeper than at present, but it has been gradually filling up, owing to the clearing off and cultivation of the banks.

The gullies leading into the stream are numerous, and every rain brings in a large amount of sand and soil. Where there was 15 or 20 feet of water twenty years ago, only 3 or 4 feet is found now. To make the bayou 100 feet wide and 6 feet deep, between Harrisburgh and Houston, it will be necessary to remove the trees and stumps from the banks and excavate 574,146 cubic yards of earth. The side-slopes must then be protected to prevent the sand and soil from washing in and filling up the channel.

Below Harrisburgh the bayou is broad and deep, and the only obstructions to navigation for vessels drawing 8 feet, between this parish and Bolivar Channel or Galveston, are Clopper's Bar and Red Fish Bar, the former at the mouth of San Jacinto River, and the latter across Galveston Bay. Red Fish Bar is made up of a series of reefs, consisting of an accumulation of shells, with a small portion of alluvial deposit. The distance across the bar is about one mile. There are two channels across the bar navigable for vessels drawing less than 4 feet of water. Clopper's Bar consists of the sediment brought down the San Jacinto River, soil and sand, which is deposited, mixed with shells, when the fresh water meets the tidal water from the Gulf of Mexico. The distance across the bar is two and a half miles, and the depth of channel 4 feet. Both bars form very serious obstructions to navigation, and may be improved by dredging.

ADVANTAGES OF IMPROVING THE BAYOU.

The advantages which will arise from opening a channel to vessels of deeper draught than those now navigating Buffalo Bayou are obvious. The city of Houston, situated at the head of navigation, is the chief railroad center of Texas.

The following roads diverge from this point: Houston and Texas Central, one hundred and sixty-five miles, completed; Houston Tap and Brazoria, fifty miles completed; New Orleans and Texas, one hundred and six miles completed; Western Branch of Houston and Texas Central, forty-seven miles completed; Buffalo Bayou, Brazos and Colorado, eighty-five miles completed; Galveston, Houston, and Henderson, fifty miles completed.

The population of Houston is 15,000. Among the business enterprises of the city are 2 cotton-factories, 3 founderies, 3 beef-packeries, 1 soap-factory, 2 bone-mills, 1 sash-factory, 2 car-factories, 1 cotton-press, 1 ice-factory, 1 gas-works, 1 National Bank, 3 banking companies, 2 insurance companies, 1 navigation company.

The bayou enables the people of Houston to establish communication by water with Galveston and the Gulf of Mexico. A large amount of freight is taken in barges from ships outside of Galveston Bar, and towed direct to Houston. The port of entry for this merchandise is Galveston. I have found it impossible to obtain from the records of the custom-house any idea of the amount thus transacted, but through the kindness of Mr. Shearne, president of the Houston Direct Navigation Company, I have obtained from the records of his office a statement of the total amount of freight transported through the bayou by the company.

For the year ending May 1, 1869, the amount of freight transported, reckoned in barrels of 5 cubic feet to the barrel, was as follows:

Number of barrels transported up the bayou	546, 608
Number of barrels transported down the bayou	268, 858
Total number of barrels transported	815, 466
Number of passengers	11, 554

I have not been able to obtain a more detailed statement of the kind and amount of freight. A large portion of the export consists of cotton, hides, and tallow. The freight brought into Texas by this route is of a miscellaneous character. It is expected that 90,000 tons of railroad iron and material alone will be brought up the bayou during the next year, for the construction of the Great Northern and International Roads in the interior of Texas.

If the navigation is improved so as to allow vessels drawing 6 feet to reach Houston, it will establish a strong opposition to the single railroad connection with Galveston. It will increase the facilities for carrying freight to and from Harrisburgh, the terminus of the Buffalo Bayou, Brazos, and Colorado Railroad. It will diminish the cost of all supplies sent into the interior of Texas, facilitate the export of produce, and aid in the construction of the railroads now being pushed forward from Houston.

For the number and class of vessels navigating the bayou, see statement appended, marked A. I also transmit with this report three sheets, showing plan of the bayou and numerous cross-sections.

The greatest rise of tide at Houston observed during the survey was 22 inches above the plane of reference; for the section of the bayou at this point, see sheet No. 1.

The stage of water in the bayou is in a great measure dependent on the direction and force of the wind, the water being lowest during the northers.

The field-work for these maps was conducted by Mr. William D. Duke, who deserves great credit for prosecuting the examination during very unfavorable weather, and for collecting a large amount of information in a short time and at little expense.

There are two dredge-boats now at work in the bayou, owned by the Buffalo Bayou

Ship Channel Company. This company has a charter from the State of Texas, and is authorized by the city of Houston to collect a tax on commerce for wharfage and tonnage, and a certain additional tax when the bayou is widened and deepened so as to admit vessels of greater draught. They are making the revenue more secure by cutting a channel across Morgan's Point, from Galveston Bay into the San Jacinto River, so as to avoid Clopper's Bar and at the same time oblige deep-draught vessels to pass through a canal owned by the company.

The obstructions to navigation between Bolivar Channel and Houston are Red Fish Bar, Clopper's Bar, and the want of sufficient depth and width in the bayou for eight miles between Harrisburgh and Houston.

ESTIMATES.

The following estimates are submitted to show the cost of the improvements desired:

I. For a channel 100 feet wide and 6 feet deep at mean low tide:

For Red Fish Bar, 21,121 cubic yards of excavation, at 50 cents	$10,560 50
For Clopper's Bar, 104,489 cubic yards of excavation, at 50 cents	52,244 50
For removing stumps and trees from banks between Harrisburgh and Houston	7,000 00
For widening and deepening the bayou at same point, 574,146 cubic yards of excavation, at 50 cents	287,073 00
For protecting the channel by sheeting-piles, where necessary, between Harrisburgh and Houston	25,139 00
Total	382,017 00

II. For a channel 150 feet wide and 6 feet deep at mean low water:

For Red Fish Bar, 30,898 cubic yards of excavation, at 50 cents	$15,449 00
For Clopper's Bar, 153,377 cubic yards of excavation, at 50 cents	76,688 50
For removing stumps and trees from banks between Harrisburgh and Houston	10,000 00
For widening and deepening the bayou at the same point, 1,600,937 cubic yards of excavation, at 50 cents	800,468 50
For protecting the channel by sheeting-piles, where necessary, between Harrisburgh and Houston	37,709 00
Total	940,315 00

I have also estimated the cost of excavating a channel 150 feet wide and 12 feet deep through Galveston Bay and Buffalo Bayou to Houston, as proposed by the Buffalo Bayou Ship Channel Company.

Amount of excavation between Bolivar Channel and the mouth of the San Jacinto: 2,786,455 cubic yards, at 50 cents	$1,393,227 50
For removing stumps and trees from banks between Harrisburgh and Houston	10,000 00
Amount of excavation between the mouth of San Jacinto and Houston, 4,079,771 cubic yards, at 50 cents	2,039,885 50
Total	3,443,113 00

The average depth of water through Galveston Bay is 8¼ feet. The bottom is composed of soft mud, sand, and shells. The channel will not remain open when excavated, but will require constant dredging or a protection on both sides for twenty miles, through the bay, similar to that adopted for the canal through the St. Clair Flats; but even this, if constructed, would only stand a few years on account of the rapid destruction of timber in this latitude by the ship-worm *teredo navalis*.

If any improvement is to be attempted by the General Government, I would recommend the first plan, *i. e.*, for a channel 100 feet wide and 6 feet deep. Estimated cost, $382,017.

In opening a channel across Red Fish Bar, the dredging should be done in what is known as West Pass, this being the most favorable on account of the narrowness of the bar at this point.

The estimate for Clopper's Bar is for opening a channel across the bar along the line traced in red on sheet No. 2, this being the most favorable, considering the present depth of water and direction of the current.

Very respectfully, your obedient servant,

H. M. ADAMS,
First Lieutenant Engineers, U. S. A.

Captain C. W. HOWELL,
Corps of Engineers, U. S. A., New Orleans, Louisiana.

A.—*Vessels navigating Buffalo Bayou.*

Name.	Class.	Length.	Beam.	Tonnage measurement.
		Feet.	*Feet.*	
T. M. Bagby	Steamboat	175	50	508
Diana	do	171	32	450
Henry Jones	do	130	32	275
Era No. 3	do	140	32	377
Mary Conoly	do	125	32	300
S. J. Lee	do	130	29	200
Caddo	do			250
C. K. Hall	do			120
Royal Arch	do			65
Bagdad	do			225
Wren	do			301
Crescent	Tug			140
Buck	do			10½
Alert	do			
Superior	do			14
Ontario	do			8
Seven (7) barges		126	26	959
Twenty-one (21) small schooners				602
Total tonnage				4,804½

N 6.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., April 29, 1871.

GENERAL: In compliance with your instructions, dated Office Chief of Engineers, Washington, July 23, 1870, I have the honor to report that I have caused to be made by my assistant, Gustave Dyes, civil engineer, a survey at the mouth of Trinity River, Texas. The report of Assistant Dyes, and the chart which he has prepared to accompany it, are forwarded herewith.

I coincide with Mr. Dyes in his opinion that Pass A should be preferred for improvement, in case any improvement at the mouth of Trinity River be undertaken by the General Government. I also approve the plan recommended by Mr. Dyes, but as I have reported in regard to the estimate for the mouth of Sabine River, must add to the estimate here, in order to guard against the contingency of purchase of dredging-machinery, &c. For further information, I refer to my report of this date, on the mouth of the Sabine River.

I submit the following estimate, viz:

Estimate of Mr. Dyes	$15,942 00
One-half cost of dredging-machinery	21,300 00
Total	37,242 00
Add for contingencies	2,758 00
Total	40,000 00

The work is located in the collection district of Galveston, and the nearest light-house is that on Red Fish Bar, Galveston Bay.

I have the honor to be, very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, La., March 6, 1871.

SIR: You are charged with the duty of making an examination and survey of the mouth of Trinity River, Texas, for the purpose of obtaining full and reliable information on which to base a plan and estimate for work of improvement, designed to deepen the main outlet of the river, so as to admit the entrance of vessels drawing 5 feet.

You will first make an examination of the passes through which the river debouches into Galveston Bay; to ascertain the present condition as regards depth of water in each pass, and over the bar at its mouth; the length of each bar and its character; determine the volume of discharge through each pass by measuring a cross-section, and observing for velocity of current; further, observe the velocity of current over each bar. It is only deemed necessary to make an approximation in determining these points. Having collected the information indicated above, you will be able to decide on a practicable plan for making the desired improvement.

Having decided on a plan or plans you wish to recommend, make a careful survey, to furnish all the data required for making an estimate of the probable cost of carrying out each plan.

Lastly, all attainable information regarding facilities for obtaining labor and material for the work you recommend; also regarding the amount of commerce to be benefited by the work, should be collected.

On completion of the field-work of the survey, you will return to New Orleans, and report to this office in writing, giving full account of the conduct of the survey, and such other information as this letter of instructions calls for; also giving your plans, estimates, and recommendations for the proposed work of improvement. The report should be accompanied by charts of the survey, fully illustrating the plans you present.

It is expected you will be able to charter a proper vessel, employ boatmen, and purchase provisions at Galveston. A small sailing-vessel, with accommodations for yourself and three men, will be most suitable for your purpose.

The early completion of your field-work and economy of expenditure are desirable. The sum of $300 is furnished you to cover expenses on the field-work, excepting your own salary and mileage from and to New Orleans.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.
Pr. H. M. ADAMS,
First Lieutenant Engineers.

Mr. GUSTAVE DYES, C. E.,
New Orleans, Louisiana.

UNITED STATES ENGINEER OFFICE,
New Orleans, April 26, 1871.

CAPTAIN: In compliance with your letter of instructions, (prefixed,) dated March 6, 1871, I have completed a survey of the mouth of Trinity River, Texas, and submit herewith my report, accompanied by a chart of the survey:

Trinity River debouches into Galveston Bay through three main outlets or passes, and into Turtle Bay, which is connected with Galveston Bay through several and comparatively insignificant passes or bayous. The whole of the delta thus formed, from the village of Wallaceville, which is located about two and a half miles above the heads of the main passes to the bays, is a low, marshy formation, elevated about 15 inches above the surface of the river, during its low-water stage, and, at every considerable rise in the stream, entirely overflowed. The bed of the river and the passes is of the same character as the banks. During floods, sand and lighter material is brought down from the upper river and deposited at the mouths of the several outlets, forming bars by the action of the flood-tides coming from the Gulf of Mexico through Galveston Bay. The material of these bars, as fast as deposited, is assorted, and the lighter portion cast back on the shores of the delta, while the sand is left as the predominating material of the bars.

Pass A (see chart) is the only one now in use by steamboats and other vessels, as it presents the least obstruction of any to navigation. It was dug out by the United States Government in 1865, to facilitate the supply of fuel to the troops stationed in Galveston; it debouches into the strait connecting Turtle and Galveston Bays. It is obstructed by a bar at its debouche into the strait, which admits over it vessels drawing not more than 4½ feet, which depth would be sufficient were it not for the extreme narrowness of the channel affording that depth. The crossing is 1,400 feet in length, 20 feet wide for 4½ feet depth, and from that shoaling each side until, at a distance of 75 feet from the center, the depth is decreased to 1 foot. A number of logs adds to the obstruction. The most serious obstruction to the use of this pass is found where the strait debouches into

Galveston Bay, in a bar which, for a distance of 2,500 feet, has for the average depth of water over it 3.75 feet.

The middle or main pass was the one formerly used; it debouches directly into Galveston Bay; discharges a greater volume of water and with greater velocity than any of the others; its bar, however, is very long and shoal, giving for a distance of 3,500 feet only an average depth of 2.7 feet. These two passes are the only ones worthy of any attempt at improvement; and in deciding between them, I have been governed by considerations other than the ones usually made prominent, viz: volume of discharge and velocity of current.

Considering the relative exposure of the bars at the two passes to the injurious action of southerly and easterly storms, which sweep up Galveston Bay, we find that Pass A is well protected by the high land opposite its debouche, and that an excavation through the outer bar can be secured by a comparatively cheap breakwater, serving at the same time as a guide for the current through the strait.

At the mouth of Middle Pass there are no such advantages, considering the amount of excavation required at each, to give a channel 4½ feet deep and 150 feet wide. The following figures show greatly in favor of Pass A, viz:

Middle Pass Bar, 3,500 feet by 150 feet by 1.8 feet		35,000 cubic yards.
Pass A, (inner bar,) 1,400 feet by 130 feet by 2 feet	13,481	
Pass A, (outer bar,) 2,500 feet by 150 feet by 75 feet	10,453	
		23,934 cubic yards.

There is further to be considered the commerce of Turtle Bay, which will be benefited by improving the entrance to the bay, and the interests of the settlement opposite to the mouth of Pass A, the port of a fine agricultural country on the east shore of Galveston and Turtle Bays, and a place of considerable trade; one of the beef-packing establishments alone packing 6,000 beeves per annum.

The relative cost of improving the two passes is shown below, viz:

Pass A, dredging 23,934 cubic yards, at 50 cents	$11,967 00
Breakwater at mouth, 10,000 piles, at 15 cents	1,500 00
Breakwater on bar in bay, 12,000 piles, at 15 cents	1,800 00
Removal of logs, 27, at 25 dollars each	675 00
Total	15,942 00
Middle Pass, dredging 35,000 cubic yards, at 50 cents	17,500 00
In favor of Pass A	1,558 00

In conclusion, I have to recommend that if any improvement be attempted, Pass A be selected for the work; that channels 150 feet wide and 4½ feet deep be excavated through its inner and outer bars, and that the excavation be protected by pile breakwaters, located as shown on the accompanying chart.

At the head of Pass A there is a raft formed about obstructions placed in the stream during the rebellion; these, however, do not impede navigation, and are useful in catching drift-wood, brought down the river in considerable quantities during floods, and closing the small outlets into Turtle Bay.

The commerce to be benefited by the improvement I have recommended gives employment to nine steamboats making regular trips up the Trinity during the active season, and to twenty-five sailing craft, conveying to Galveston about 15,000 bales of cotton and about 2,000,000 feet of lumber per year. I make this only as an approximate statement, having been obliged to collect my information from various sources. No statement of return freight could be obtained.

The following table, showing the observed depth, width, velocity, area of cross-section, and volume of discharge of the river and its outlets, is submitted, viz:

Places of observation.	Greatest depth.	Width.	Observed mean velocity.	Area cross-sections.	Volume.
	Feet.	*Feet.*			
Pass A	9½	85	0.7962	591.60	471
Pass B	8	140	0.8365	901.60	754
East Pass	11	184	0.8365	1,197.84	1,002
Trinity River	23½	617	1.2798	7,602	9,729
Southwest Pass	13	271	0.9832	2,252	2,114
Middle Pass	12	377	1.1123	3,328.91	3,703
Pass C	11½	170.5	0.9932	1,147.46	1,140

In conclusion, I have the honor to be, very respectfully, your obedient servant,

GUSTAVE DYES,
Civil Engineer.

Captain C. W. HOWELL,
Corps of Engineers, U. S. A., New Orleans, Louisiana.

N 7.

UNITED STATES ENGINEER OFFICE,
New Orleans, *April* 28, 1871.

GENERAL: In compliance with your instructions, dated Office of the Chief of Engineers, Washington, July 23, 1870, I have the honor to report that I have caused to be made, under the personal supervision of Civil Assistant Gustave Dyes, civil engineer, a survey at the mouth of the Sabine River.

The report of Assistant Dyes, and the chart which he has prepared to accompany it, are forwarded herewith.

The Sabine debouches through four passes into Sabine Lake, and thence into the Gulf of Mexico through Sabine Pass; the bar at the entrance to this pass usually affords 7 feet of water, and during continued southerly gales, 9 feet; the lake affords at all times 7 feet until near the delta of the Sabine River.

Sabine City, located on the west bank of Sabine Pass, is the port of entry for all goods destined for the trade dependent on the navigation of the river; at this point transfer is made to and from the small steamers and sailing craft employed on the river. Without, at great expense, first improving the entrance to Sabine Pass, there can be no advantage gained by improving the entrance to Sabine River so as to admit the passage of vessels drawing more than 4 or 5 feet. Assistant Dyes estimates that, by deepening the entrance to the river to 5 feet, commerce will be benefited to the amount of about 15 or 20 per cent.; this depth has been assumed as the maximum required, and on that assumption Mr. Dyes bases his estimates for works of improvement. It is questionable whether the interest involved is of sufficient importance to warrant any attempt at improvement, since the entrance to the river is now 3½ feet deep—a greater depth than is afforded by the Missouri River, above Fort Randall, for the greater portion of the year, to accommodate the vastly more important trade with Montana, which has forced the building of steamers to suit the river, not the improvement of the river to suit the steamers.

On the supposition that it will be to the interest of the Government to improve the entrance to the river, Mr. Dyes submits a plan for the work. He first recommends dredging a five-foot channel across the bar, at the mouth of Middle Pass. This, he estimates, will remain open for about five years. To preserve it for a longer time, he recommends the use of converging jettees. Afterward, should it be deemed advisable, he recommends the closure of the cut-off and West Pass, and the revetment of the river banks to a point about one-half mile above the head of the passes. The recommendation is concurred in partially, viz: For the dredging of a channel across the bar at the mouth of Middle Pass. The other works recommended may be undertaken in the order in which they are named, should they be found necessary.

For the work of dredging, Mr. Dyes estimates $13,033, or at 50 cents per cubic yard excavated. As I have before reported, owing to the small number of dredges on this coast, the demand for them in the neighborhood of the large cities, and the comparatively small amount of work recommended at the mouth of the Sabine, which will not tempt owners from equally lucrative, larger, and more accessible works, I do not think it safe to place dependence alone on contracting for such work, and therefore add to the estimate of Mr. Dyes enough to permit the purchase of dredge-boat, scows, and tug, should advertisement for contract-work fail to meet an answer, as has already happened, much to the embarrassment of work authorized on the inner bar at Galveston Harbor, Texas.

With the estimate increased as I recommend, the work may be done by contract, if possible; if no offers for contract are made, then by purchase of dredging-machines, thus insuring the work against falling to the ground for want of money to carry it on.

As I shall make the same recommendation for work at the mouth of Trinity River, Texas, and as one dredge and accessories can be made to answer for the two works, I estimate one-half of the expense for each, viz:

One dredge-boat	$30,000 00
Two dump-scows, at $2,800	5,600 00
One tug	7,000 00
Total	42,600 00
One-half of $42,600	$21,300 00
Add estimate of Mr. Dyes	13,033 00
Total	34,333 00
Add for contingencies	3,667 00
Total estimate	38,000 00

The plan recommended is substantially the same as that recommended by Lieutenant Henry L. Smith, Corps of Engineers, United States Army, in 1853.

I have the honor to be, very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, January 23, 1871.

SIR: You are charged with the duty of making an examination and survey of the mouth of Sabine River, Texas, for the purpose of obtaining full and reliable information on which to base a plan and estimate for work of improvement designed to deepen the main outlet of the river, so as to admit the entrance of vessels drawing 5 feet.

You will first make an examination of the four passes through which the river debouches into Sabine Bay, to ascertain their present condition as regards depth of water in each pass and over the bar at its mouth, the length of each bar, and its character, determine the volume of discharge through each pass by measuring a cross-section, and observing for velocity of current; further observe the velocity of current over each bar. It is only deemed necessary to make a fair approximation in determining these points.

Having collected this information indicated above, you will be able to decide on a practicable place for making the desired improvement. Having decided on a plan or plans you wish to recommend, make a careful survey to furnish all the data required for making an estimate of the probable cost of carrying out each plan.

Lastly, all attainable information regarding facilities for obtaining labor and material for the work you recommend, also, regarding the amount of commerce to be benefited by the work, should be collected.

On completion of the field-work of the survey, you will return to New Orleans and report to this office in writing, giving a full account of the conduct of the survey and such other information as this letter of instructions calls for; also giving your plans, estimates, and recommendations for the proposed works of improvement. The report shall be accompanied by charts of the survey, fully illustrating the plan you present.

It is expected that you will be able to charter a proper vessel, employ boatmen, and purchase provisions for your outfit, either at Sabine City or Orange. A small sailing vessel, with accommodations for yourself and three men, will be most suitable for your purposes.

The early completion of your field-work and economy of expenditure are desirable.

The sum of $300 is furnished you to cover expenses in the field, excepting your own salary and milage from and to New Orleans.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Mr. GUSTAVE DYES,
Civil Engineer, New Orleans, Louisiana.

UNITED STATES ENGINEER OFFICE,
New Orleans, April 25, 1871.

CAPTAIN: In compliance with your letter of instructions (prefixed) dated January 23, 1871, I have completed a survey of the "mouth of Sabine River," and submit herewith my report, accompanied by a chart of the survey.

Sabine River empties into Sabine Lake, (more properly Sabine Bay,) through four channels, two of which are the main outlets, viz, East Pass and Middle Pass; the other two, the Cut-off and West Pass, are branches of the latter.

The shores of these passes, and of the river for several miles above them, are marshy flats, at low water being only from 0.5 feet to 1.3 feet above the surface of the stream, and at every rise being completely inundated. The soil is similar to that of the Louisiana marshes.(prairie-trees bleute,) consisting of deposits of decomposed vegetable matter, interspersed with shells; the general level is occasionally varied by shell mounds.

The country does not admit of cultivation. A few settlers have occupied the shell-mounds for shingle-yards and trading-stations, to supply the numerous small vessels which navigate the river. With the exception of a few cypress trees and pig-nut hickories, there is no timber within sight of the passes, and but little south of Orange, a small town located on the west bank of the Sabine River, about twelve miles above its mouth.

The beds of the passes are of a yielding, marshy nature, similar to their embankments, while the bars which obstruct their outlets into the lake are almost entirely composed of sand and shells, having only here and there a small strip of mud bottom, not more than two feet wide, marking the center of the channel.

The current of the passes decreases greatly in velocity as it approaches the lake, and is felt but a short distance out; it deposits on the bars mud and sand. The mud during flood-tide is swept back to the shore, leaving the sand to consolidate with the shells, which are probably grown in place, and form the bar. There is but little drift-wood brought down the river, and there are no log obstructions in any of the passes or on the bars. With the exception of the bars referred to, the river as well as the lake are in good navigable condition, admitting all kinds of vessels calculated to do a river business. The entire agricultural product of a large tract of country is conveyed to market via Sabine River.

The channel now used by vessels is that through the Cut-off and Middle Pass. In 1861 the mouth of Middle Pass was obstructed by sunken flat-boats, (that being then the main channel,) and such improvements as have been since attempted have been made at the mouth of the Cut-off, which now gives a channel 0.5 feet deeper than that across the bar of Middle Pass. The flat-boat obstructions referred to are now out of the channel, and will not be in the way of improvements projected at the mouth of Middle Pass.

Middle Pass is by nature intended to be the navigable outlet of the Sabine River, and should it be deemed of importance to improve the entrance to the river so as to give admission to vessels drawing 5 feet, I recommend the work to be done at the mouth of Middle Pass.

The plan of dredging a channel across the bar at the mouth of the pass is the only one which offers certain results, and is the one which I recommend. It may be found advantageous, after the excavation has been made, to partially protect it by piling, which shall combine the useful qualities of a breakwater to protect the excavation from the lake side, and of jettees, to concentrate the river discharge upon the bar. I have estimated for both, believing that by the use of breakwaters or jettees the stability of the channel will be greatly increased. Should dredging alone be resorted to, it is probable that the channel excavated will practically remain unimpeded for four or five years, since the sediment annually deposited by the river only amounts to about 0.09 feet.

The nature of the soil forming the delta of the Sabine does not encourage a project for closing the passes diverging from Middle Pass. It is presumed that were these passes closed during floods in the Sabine, inundating the whole delta, the water would, instead of following the Middle Pass, were the lateral outlets closed, cut for itself other outlets through the marshy formation, unless care were taken to protect the banks for a distance of at least half a mile above the head of the passes, an undertaking the expense of which can never be warranted by the amount of commerce to be benefited.

For opening a channel 5 feet in depth through the bar at the mouth of the Middle Pass, I estimate the excavation of 26,066 cubic yards of earth, at 50 cents per yard, $13,033. For converging jettees 250 feet in length each, to concentrate the discharge of the pass, I estimate $1,800. No estimate is submitted for breakwaters, because of uncertainty as to the development which it will be necessary to give them. Should it be deemed advisable to close the Cut-off and West Pass, I offer as an estimate for expense of protecting the banks of the river the following:

For shell embankments, 14,260 cubic yards	$7,130 00
Piling 20,816, at 15 cents	3,122 40
Total	10,252 40

I present the following table:

	Cross-section.	Width.	Observed mean velocity.	Volume.	Slope.	Depth in channel.	Remarks.
					Feet.	*Feet.*	
Sabine River	10,172	751	2.235	22,736	0.0000376	24	
Middle Pass	6,661	388	1.613	10,744	0.0000234	30	
East Pass	4,007	294	1.5632	6,264	0.0000217	24	315 feet at mouth; depth, 18 feet.
West Pass	891	101	1.1203	998	0.0000173	11	120 feet at mouth; depth, 13 feet.
Cut-off	1,287	156	1.391	1,790	0.0000136	13.5	165 feet at mouth; depth, 14 feet.

Also, following statement of commerce to be benefited by the proposed improvement, as shown by the records of the custom-house at the port of Sabine for the year ending August 31, 1870:

IMPORTS.

From—	Salt.	Flour.	Whisky.	Sugar.	Coffee.	Merchandise.	Hardware.
	Sacks.	*Bbls.*	*Bbls.*	*Bbls.*	*Sacks.*	*Cases.*	*Pkges.*
Galveston	4,704	10,734	584	144	800	16,989	5,663
New Orleans	727	4,457	270	66	630	3,240	807
All other ports	....	200	....	25	....	....	....
Total	5,431	15,391	854	235	1,430	20,229	6,470

EXPORTS.

To—	Lumber.	Shingles.	Cotton.	Wool.	Hides.	Tallow.	Beeves.	Calves.
	Feet.	*Per M.*	*Bales.*	*Bags.*	*No.*	*Tierces.*	*No.*	*No.*
Galveston	1,565,575	28,906,050	10,280	41	14,140	927	....	....
New Orleans	....	....	3,347	50	710	30	4,270	3,439
All other ports	1,000,827	7,153,950	....	....	....	....	....	....
Total	2,566,402	36,060,000	13,627	91	14,850	957	4,270	3,439

It is presumed that with increased facilities for navigation the commerce of the river will be benefited from 15 to 20 per cent.

Piles can be obtained within seventy-five miles of the passes. Shell-banks on the delta will supply the demand for embankment, and a dredge-boat can be built at Sabine City.

Very respectfully, your obedient servant,

GUSTAVE DYES,
Civil Engineer.

Captain C. W. HOWELL,
Corps of Engineers, U. S. A., New Orleans, Louisiana.

N 8.

UNITED STATES ENGINEER OFFICE,
New Orleans April 7, 1871.

GENERAL: I have to submit the report of Lieutenant H. M. Adams, Corps of Engineers, United States Army, on a survey made at Brazos Santiago, Texas, in February, 1871.

The work is located in the collection district of Brownsville, Texas, near the port of Brazos Santiago, and the light-house on Brazos Island, Texas. Commercial statistics will be forwarded when received.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, January 27, 1871.

SIR: You are assigned to the duty of making an examination and survey of the harbor and pass of Brazos Santiago, Texas, for the purpose of collecting all information needed to form plans and estimates for such work of improvement as you may recommend be undertaken by the General Government to deepen a channel across the bar at the entrance to the pass, and to protect the harbor.

You will be guided by verbal instructions received and by your own judgment as to the nature of examination to be made, as to extent and character of survey required.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

First Lieutenant H. M. ADAMS,
Corps of Engineers, U. S. A., New Orleans, Louisiana.

NEW ORLEANS, LOUISIANA, *March* 13, 1871.

SIR: I have the honor to submit the following report in compliance with the above letter of instructions.

I left New Orleans on the 28th January, arrived at Brazos Santiago and commenced examination February 1. We were enabled to finish the field-work in time to return to New Orleans by the first steamer arriving here on 25th of February.

The harbor of Brazos Santiago is situated about ten miles from the mouth of the Rio Grande. Nearly all freight brought to this point is immediately shipped on the river steamers, which run up the Rio Grande to Brownsville and Matamoras. The depth of water on the bar at the mouth of the river is 4 feet. This makes it necessary to "lighter" everything destined for Brownsville.

The harbor at Brazos affords a good position for shifting freight from vessels which cannot cross the Brazos bar or to the river steamers which can cross the bar at the mouth of the river. All merchandise to be shipped from Brownsville is brought down the river and around through the Gulf to Brazos and then reshipped.

The harbor at Brazos affords a secure anchorage and good point for reshipping freight in transitu to and from Brownsville. The entrance to the harbor, like the entrance to all harbors on the coast of Texas, is obstructed by a bar not extending directly across the mouth of the pass, but from points of the shore above and below, in a curved form, out to sea. The bar is situated so as to be entirely exposed to the action of heavy storms; it is composed of a quicksand formation, acted upon with extraordinary facility by water. The channel across the bar is constantly shifting and cannot be depended on from day to day. The depth of water at the time of the examination was 7 feet at high tide.

The greatest depth of water in the harbor is 27 feet. The channel from Brazos to Point Isabel is 5 feet deep to within 100 yards of the old wharf at the point.

I submit with this report a sketch showing the present condition of the bar, the pass, and the harbor.

The improvement desired is a deeper channel across the bar. The harbor is ample for the commerce of the port and needs no protection.

The small pass south of Brazos, called Boca Chica, was closed up in 1868, with the hope of *increasing* the amount of water flowing through the Brazos Pass, and the depth of water on the Brazos Bar by increasing the scouring effect of the ebb tide. Boca Chica remains completely closed, but the Brazos Bar has not been improved.

From the best information which I have been able to collect, I am satisfied that the views submitted to the Chief of Engineers by Captain McClellan, in 1853, in regard to this bar, were undoubtedly correct. The examination which I have just made convinces me that his report is a concise and exact statement of the case. The main features of the harbor and bar have not in any particular changed, and I therefore submit the same opinion:

"I regard it as impossible to improve the bar by dredging, scraping, or any similar means; for, supposing that means may be formed to overcome the difficulty of working on the bar so exposed, and that the channel were actually deepened to the required extent, it is certain that the same causes which now operate in so constantly shifting the position of the channel would almost immediately fill up any new one made by artificial means."

The bar as it stands is the result of the joint action of the ebb current from the bay and the wind current and sea along the shore. The latter are constantly working to diminish the depth, while the former is striving to increase it.

The present depth is the result of an equilibrium between the opposing forces. Dredge the bar to a greater depth, the equilibrium will be destroyed, and the outside current referred to will restore it. The present depth is all that the ebb current needs, and all it can get and hold from the opposing forces.

Deepen the bar by dredging to-day, and it will fill up again to-morrow or a week hence. Such an improvement, if possible, would be of the most transitory character, as is clearly proved both by reason and experience.

This must not be considered as applying to such bars as those at the delta of the Mississippi, where the current is always outward, and where the bars are formed by deposits from the current, totally different laws applying to such bars as these.

The depth of water on the Brazos Bar is always increased by a strong north or northwest wind, but it takes only a few days of calm weather to restore the original depth. The depth of water on the bar in 1853 was reported as varying between 6½ and 8 feet. It is about the same now, being greatest during the winter and spring, when the prevailing winds are from the north, and least in summer, when there are fewer storms and more southerly winds.

It remains to be considered whether it is possible to improve the bar by contracting or changing the channel by means of dikes, jettees, &c.

The only possible application of dikes, in this case, would be to prolong the walls of the outlet until they reached a point very near the present position of the bar, in order to concentrate upon one spot the whole action of whatever outward current there might be. The immediate effect of this might be favorable. The ultimate effect would undoubtedly be the formation of a new bar outside the present one, and that at no distant period.

The foundation of the dike would be in quicksand, and the difficulties of construction would be very great.

I have estimated the cost of a single concrete jettee of this kind, to be built out from the shore on the line A B, (see accompanying sketch,) the foundation to be constructed by covering the bottom with a layer of gunny sacks filled with hydraulic concrete. The sacks, being made of a loose coarse material, will retain the concrete in position, while a small portion will ooze through the pores of the cloth, and in a measure unite the bags.

The bottom should also be covered on both sides in this way, for a distance of 15 feet. In view of the character of the bottom and distance the jettee will probably settle, the average cross-section is taken at 22 feet in width by 15 feet in height, the width being, at every point, 50 per cent. greater than the height. The jettee head should be circular, and 50 feet in diameter. Above the foundation the jettee may be built of blocks of hydraulic concrete. The concrete blocks are proposed to be laid without mortar, in courses, and to be lowered into position by means of cranes. If necessary, piles on each side of the jettee, with string-pieces and cross-pieces, may be used as guides in laying the blocks, and to bind them together as proposed by General McAllister in his plan for improving Galveston harbor, 1868.

This kind of construction adopted for the purpose of estimate is the most economical consistent with any assurance of stability practicable on the Texas coast.

The method proposed for securing a foundation for the jettee has, I am told, been used with success.

The jettee constructed in 1870 of piles by the city of Galveston, in the same kind of quicksand as that of the Brazos Bar, was undermined at the outher end, and about 100 feet carried away soon after it was finished.

ESTIMATE.

1,752 palmetto piles, 25 feet long, at 30 cents per running foot	$13,140 00
148,197 feet, board measure, 8 by 8-inch timber, for capping-pieces and cross-ties, at $50 per M	7,409 85
3,506 bolts, 1 by 18 inches, (13,961 pounds,) at 12 cents	1,675 32
For cutting and fitting capping and cross-ties, at 75 cents per pile	1,314 00
For driving 1,752 piles, at $2	3,504 00
30,610 sacks, at 20 cents	6,122 00
49,431 cubic yards concrete, at $15, laid in jettee	741,465 00
Total cost of jettee	774,630 17

If, after constructing a jettee of this kind, it is found that the bar has only moved farther out into the Gulf, which will probably be the case, it will then be necessary to prolong the jettee to the new position of the bar.

The object of submitting this estimate is to show the cost of what is believed to be the best plan for improvement. The necessities of the case do not seem to call for such an expenditure.

Appended, and marked A, is a statement showing the number of clearances of vessels from Brazos, for the years 1869 and 1870.

Application was made, February 2, to Mr. A. M. Burney, collector at Brownsville, for a detailed statement showing the kind and amount of merchandise imported and exported by way of Brazos. The answer to this request is appended, and marked B. Application has also been made to the agent of the Morgan Line steamers, and to the agent of King & Kennedy line of river steamers, for statistics showing the amount of freight carried in and out of this port.

Very respectfully, your obedient servant,

H. M. ADAMS,
First Lieutenant Engineers.

Captain C. W. Howell,
Corps of Engineers, U. S. A., New Orleans, Louisiana.

A.—*Abstract of tonnage, &c., of vessels which have entered at the port of Brazos Santiago Texas, in the year ending December* 31, 1869

Month.	Number of vessels.	Foreign tonnage.	Licensed tonnage.	Number of crews.
January	10	296.02	4,754.33	206
February	9	....	4,183.33	181
March	9	....	3,136.27	152
April	9	....	2,777.98	122
May	9	....	3,498.48	170
June	7	....	2,829.04	134
July	13	161.00	4,112.29	203
August	12	237.65	3,687.71	222
September	5	....	2,574.60	124
October	4	....	2,328.79	103
November	7	....	3,198.41	139
December	8	25.89	4,309.16	207
Total	......	720.56	41,390.39	1,963

Abstract of tonnage, &c., of vessels which have entered at the port of Brazos Santiago, Texas, in the year ending December 31, 1870.

Month.	Number of vessels.	Foreign tonnage.	Licensed tonnage.	Number of crews.
January	8	....	4, 595. 32	212
February	9	101. 00	4, 637. 81	167
March	8	....	4, 910. 17	174
April	8	....	4, 265. 45	144
May	8	....	3, 792. 08	124
June	9	98. 60	2, 721. 18	116
July	5	71. 64	2, 486. 27	85
August	8	....	3, 294. 97	129
September	9	101. 00	3, 481. 06	148
October	4	....	526. 00	32
November	6	....	2, 954. 00	94
December	4	....	2, 140. 00	70
Total	......	372. 24	39, 804. 31	1, 495

B 2.

CUSTOM-HOUSE, *Brownsville, Texas, April* 13, 1871.

SIR: In response to your request for statistics as to the quantity and description of merchandise passing through the port of Brazos de Santiago during the year 1869, 1870, I have to state that the imports amount to the sum of $1,668,663; that the exports amount to the sum of $2,624,794; total, $4,293,457; and consist of the following principal articles: Hides, wool, goat-skins, coffee, sugar, cigars, cocoa, dry-goods, machinery, tobacco, wines, liquors, &c. It will be a work of considerable magnitude to furnish the actual quantities and values of each specific article, and with the present force in this office it will be impracticable for me to make a full and complete report at once. Should it be deemed necessary for your purposes, however, I can give you such a report, but must take time for it, as I cannot omit my regular reports and returns to the Department. I attempted to give you a full report, but found that it would require so much labor and time that I deemed it best to give you the total values now, hoping that it may be sufficient for your purposes.

Yours, &c.,

A. M. BARNEY, *Collector.*

HENRY M. ADAMS,
First Lieutenant Engineers, Box No. 950, *New Orleans, Louisiana*

The above amounts do not include articles the growth, produce, and manufacture of the United States, but foreign merchandise, or bonded goods.

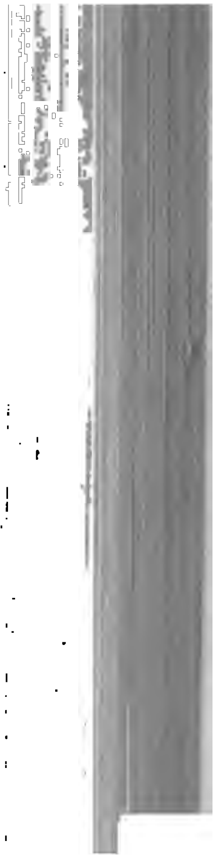
A. M. B.

N 9.

UNITED STATES ENGINEER OFFICE,
New Orleans, Louisiana, July 24, 1871.

GENERAL: In compliance with instructions dated Office of the Chief of Engineers, Washington, D. C., March 15, 1871, I have caused to be made an examination at Mississippi City, State of Mississippi, for a harbor at that place connecting with Ship Island Harbor. The report of First Lieutenant H. M. Adams, Corps of Engineers, United States Army, who conducted the examination, is submitted herewith.

The report of Lieutenant Adams deals simply with the question of construction and cost of a channel to connect an artificial harbor at Mississippi City with Ship Island Harbor. No estimate is considered necessary for the construction of the harbor itself, the cost of the connection being considered sufficient to condemn the project, not as impracticable, but as not warranted by the interests to be subserved.



Sir: In compliance with your instructions of the 11th instant, I h
following report on the examination which I have just completed at M

Mississippi City is situated on Mississippi Sound, in the collection
St. Louis, about nine miles from the light-house at Biloxi, Mississi
miles from Ship Island light.

It is neither a port of entry nor delivery, and has no commerce. Th
was chartered some years ago, but has never been built. At present
few houses scattered along the beach, the whole population being less th
The city is without any natural advantages except those of a summer
There is no harbor, the place being situated directly on the open beac
almost a straight line from Bay St. Louis to the Bay of Biloxi, Mississ
midway between the two bays. (See accompanying chart.) There is
expect that Mississippi City will ever become anything more than
retreat for the citizens of Mobile and New Orleans during the warm weat
season.

The object of the survey and examination may be inferred from an a
lature of the State of Mississippi, which is appended to this report, and

Ship Island Harbor is situated just opposite Mississippi City, and distan
It is proposed in the sixth section of the act referred to to connect Mi
with Ship Island Harbor by a ship-canal, starting from a point (mar
accompanying chart) where the water is 20 feet deep. The distance to
Mississippi City is seven miles. The water shoals very gradually for th
tance, being only 12 feet deep five miles from shore, and 8 feet deep tw
shore.

The bottom consists of a very soft blue mud. I have made borings to
29 feet below the surface of the water, and have ascertained that the bott
same nature and same consistency for the entire depth, being so soft that
can be pushed down 18 feet into the mud by the weight of one man. It is
that a channel excavated through this material will remain open, even
possible to excavate it without first inclosing it on both sides by some
work.

The amount of excavation necessary to open a channel 200 feet wide and
(as proposed by the harbor company,) to within one mile of the shore
1,591,431 cubic yards. At 30 cents per cubic yard, this would cost $47
cost of protecting such a canal on both sides for a distance of six miles w
mous. The cheapest kind of pier, which will at the same time have suffic
to resist the action of the waves at this locality, is a crib-work filled
The cribs may be built of palmetto logs or of the cabbage tree, these being
withstand the action of the ship-worms, which are very destructive in t
Yellow pine would be the cheapest, but it could not last more than two
the palmetto will stand fifteen or twenty years. The mean depth of

ESTIMATE.

For one crib 25 feet long:	
104 palmetto logs, 25 feet long, at 20 cents per running foot	$520 00
11 yellow-pine logs, 12 inches by 25 feet, at 10 cents per running foot	27 50
492 pounds bolts, at 8½ cents	41 82
12 days' labor, at $2 50	30 00
11,638 cubic feet stone filling in position, at 28 cents	3,258 64
Cost of crib, 25 feet long, in position, filled	3,877 96
Twelve miles of crib-work will cost	$9,828,301 82
Add cost of excavating	477,429 30
Total cost of canal	10,305,731 12

This sum represents only the cost of constructing a canal 200 feet wide and 20 feet deep at mean low water from Ship Island Harbor to within one mile of Mississippi City, as proposed by the harbor company. There is no harbor at Mississippi City, and no durable material with which to construct an artificial harbor. The commerce of this village does not demand any increased facilities, and I can see no reason for recommending any attempt by the General Government to make a sea-port at this point.

Very respectfully, your obedient servant,

H. M. ADAMS,
First Lieutenant Engineers.

Captain C. W. HOWELL,
United States Engineers.

A.

LAWS OF THE STATE OF MISSISSIPPI, PUBLISHED BY AUTHORITY.

AN ACT to incorporate the Harrison Harbor Company.

SECTION 1. *Be it enacted by the legislature of the State of Mississippi,* That Richard F. Harrison, William H. Tegarden, James N. Bradford, Alexander P. Harrison, John Hartigan, and William R. Pile, and all others who may hereafter become associated with them, and their successors and assigns, be, and they are hereby, created a body-politic and corporate, under the name and style of the Harrison Harbor Company, and by that name shall have perpetual succession, may sue and be sued, plead and be impleaded, in all courts of law and equity in this State; may have a common seal, the same to alter at pleasure; may make any and all by-laws, rules and regulations for the management of its business, property, and effects, and for the transfer of its stock, as to them may seem best.

SEC. 2. *Be it further enacted,* That the general purposes and objects of this corporation, the pursuit of which is hereby granted, are hereby defined to be as follows:

First. To dredge a ship-channel, of sufficient capacity to float the largest merchant vessels from the Gulf of Mexico to the main shore of Mississippi Sound, in Harrison County, in this State, and to construct embankments, wharves, and docks, as the nucleus of a marine port within the State of Mississippi.

Second. To adjust the costs and charges for the use of the channel and wharves on such reasonable terms as to invite business by sea and land, and to that end to fix low charges for the use of the channel and wharves as maximum rates, which will enable masters and owners of vessels to establish rates of freight between the new port proposed to be founded and foreign and domestic ports, that will compete successfully with other ports on the Gulf of Mexico for the growing business of the Northwestern States and the world.

Third. To erect wharves for grain, cotton, produce, and merchandise generally; to locate and establish yards for lumber, naval stores, lime, coal, and other articles of commerce; to sell and otherwise dispose of lands, and to establish one or more dry-docks for facilitating repairs of vessels needing such accommodations, either by constructing them or causing them to be constructed within the limits of the property of said company.

SEC. 3. *Be it further enacted,* That the said company shall have the right to purchase dredging machinery, steamboats, and scows, for the purpose of dredging said channel, and the right to contract with other parties for the performance of such work of dredging and filling, as their interest and the objects of this charter may render necessary; also, to own and to operate steam-vessels for towage of vessels in and out of said harbor, from any one place to another; also, to purchase or receive donations of such lands on the present shore of the sound as may be necessary to make the connections with the main shore of the sound, and such land in the interior as may be needed to furnish timber and earth for materials for filling up and protecting and improving the lands of said company, and to sell any and all lands so acquired when they may deem proper to do so.

SEC. 4. *Be it further enacted*, That the board of directors of said company shall consist of five members, to be elected from among the stockholders at the elections to be held in accordance with the by-laws and regulations of said company, to serve for one or more years; and the said board may elect from among their number a president or manager, and a vice-president, and they may elect or appoint a secretary and treasurer, port-wardens, wharf-masters, and such other officers as may be necessary for conducting the business of said company.

SEC. 5. *Be it further enacted*, That the said company shall have the exclusive right to reclaim the submerged or overflowed lands of Mississippi Sound for a distance of two miles south from the shore of the present main land, and for a distance of ten miles, more or less, between certain section-lines hereinafter stated, to wit: Beginning at a stake on the shore of the Mississippi Sound in Harrison County, in this State, at a dividing line between section seven and section eight in township eight (8) south and range eleven (11) west; thence running south to a point two miles distant from the said shore, in the open waters of said sound; thence in an east-northeasterly direction ten (10) miles, more or less, to a point two miles distant from the shore, and due south from the section-line dividing section thirty-five (35) from section thirty-six, in township seven south, and range ten (10) west; thence due north from said point, two miles to the said dividing line at its intersection with the line dividing the public land from the lands of private land-owners on said beach; thence in a west-southwesterly direction on the line of the several owners of land on said beach to the place of beginning; and bounded on the north by the lands of the said property owners; and on the east, south, and west by the waters of the sound. And the said company shall have the exclusive right, (in consideration of the benefits to accrue to the State at large from the establishment of a seaport on her shores,) at any time within three years from the passage of this act, to purchase from the State of Mississippi the said submerged lands, and the legislature of the State of Mississippi do hereby grant, bargain, and sell to the said company all the submerged lands embraced in the above-described limits, at ten cents per acre, the proceeds of which shall be paid into the State treasury for the credit of the school fund; and the governor of this State shall issue to the said company a complete and full title, in fee-simple, for said lands, on the payment of the price thereof into the treasury.

SEC. 6. *Be it further enacted*, That the said company shall cause to be excavated from the deep-water basin lying north from the West Pass of Ship Island to a point or points to be selected by the directors or other officers of the company, not more than two miles distant from the main shore of Mississippi Sound, in Harrison County, a ship-canal or channel, not less than two hundred (200) feet in width, nor less than twenty (20) feet in depth, to extend from the deep-water basin north of Ship Island Pass to the point or points near the main shore, as stated above; and shall, after the completion of said channel, cause it to be kept open for all vessels of burden which shall not draw over twenty feet of water. They shall build or cause to be built or constructed within the limits embraced in section 5 of this act, embankments of earth, which, when completed, shall not be less than seven (7) feet above the level of ordinary tide-water, and they may cause such embankments of land to be laid off in streets and squares, and in docks, wharves and slips, on such plan and in such manner as may to them seem best; they may also construct bridges of stone, bricks, or lumber, to connect the reclaimed land with the present shore of the sound, and to connect one part of the reclaimed land with another part thereof, in all cases where it may be necessary to do so; and they may sell or rent their lands for purposes of business or residence as to them may seem proper, and for the interest of the said company. They shall cause to be constructed wharves or docks for the convenience of vessels trading to their harbor, and may collect from all vessels drawing more than ten (10) feet of water, a channel and harbor fee for the use of said channel and harbor, not exceeding twenty-five (25) cents per ton, custom-house measurement, for each voyage, and from all vessels lying at their wharves they may collect a wharfage fee of not more than ten (10) cents per ton, custom-house measurement, for each voyage or trip of such vessels, and they shall have the right to commute by the month or year with masters and owners of any vessels, or line of vessels, or packets, for such wharfage. And any vessel that is liable for channel and harbor fees, or for wharfage, under the provisions of this act, whose captain, owner or agent neglects or refuses to pay the same, shall be liable to be sued for the amount of such fees and wharfage, together with the costs of suit, before any court of competent jurisdiction, at any time within three years after such fees or wharfage shall become due. And no person shall have the right to obstruct or encumber the wharves or streets by allowing goods or merchandise to remain thereon an unreasonable length of time; and any person or persons so offending against the provisions of *this act* may be sued by the said harbor company; and said company may recover such fine or fines as they may, by their by-laws, declare to be taxable on such obstruction or encumbrance.

SEC. 7. *Be it further enacted,* That the said company shall commence the work of dredging said channel within three (3) years from the passage of this act, and shall complete so much of the work within the next five (5) years after the first three years as shall afford navigation the entire length of the said channel, from the West Pass of Ship Island to the wharves of said company, for vessels drawing twenty feet of water.

SEC. 8. *Be it further enacted,* That the said company may construct a breakwater of earth, stone, brick, or timber, or any other material, for the protection of their property, and of vessels lying within the banks, or outside of the banks, from the effects of storms and gales; and the line of said breakwater may be at such distance from the wharves and docks of said company as they may determine upon, and the said company may deepen the waters in the space lying between the breakwater and their wharves and docks, for the purpose of affording facilities for moving vessels about the harbor, and to supply the said company with materials for filling up and reclaiming their lands.

SEC. 9. *Be it further enacted,* That it shall not be lawful for any person or persons whomsoever, except the said Harrison Harbor Company, to dig or excavate any channel within the limits of that portion of Mississippi Sound which forms the present harbor or anchorage known as Ship Island Harbor, or to construct embankments, breakwaters, docks, or any other obstruction outside or south of the tract herein sold to said company, or in any way interfere with the rights and privileges of said company, by excavating a channel which shall at any point approach the line of their channel as near as ten miles on the east or west of said line, and any person or persons violating their privileges may be enjoined, and shall be liable to the said company in an action for damages.

SEC. 10. *Be it further enacted;* That it shall not be compulsory upon masters or owners of vessels to employ pilots to cross the bar at Ship Island Pass, or to make the run of the channel, going in or out of the harbor, other than the regularly-employed navigators of such vessels, except so far as may be required to satisfy the insurers of such vessels and their cargoes, or any law of Congress relating to pilotage. Nor shall it be lawful for pilots, port-wardens, or harbor-masters to demand and collect fees from vessels trading to said harbor, except for services actually performed.

SEC. 11. *Be it further enacted,* That the said company is authorized and empowered from time to time to borrow money, or to procure work to be done on its own credit, for the purpose of carrying out the purposes and objects of this act of incorporation; and as evidence of the indebtedness of the company for such loans, or for such work done or performed for said company, may issue its corporate bond or promissory notes, bearing interest at a rate not exceeding eight per cent. per annum, and to secure the payment of said bonds and notes, may mortgage its capital stock, its corporate franchises, and any of its real and personal property, or any part or portion of the same, and it may, by its manager or other officers or agents, duly authorized by its directors, sell, dispose of, or negotiate such bond and notes, or may sell, dispose of, or negotiate its capital stock, or any of its real or personal property, at such times and places and at such rates and for such prices, either within or without the limits of this State, or in any European city or state, as, in the judgment of said company or its directors, will best advance its interests; and if such bonds, notes, and stocks are thus sold at a discount, such sales shall in all respects be valid and binding on this corporation; and such stock, bonds, or notes shall be as valid for the par value thereof as if the same had been sold at par value.

SEC. 12. *Be it further enacted,* That the said company may construct or cause to be constructed one or more dry-docks for the convenience of vessels needing repairs, and may collect from said vessels a fee or compensation for the use of such dock or docks corresponding with the charges made in other marine ports for such accommodation, and they may sell or otherwise dispose of such dock or docks at such time as they may deem proper, and parties to whom they may sell or otherwise dispose of such dock or docks may charge and collect a fee for the use of such dock or docks, at such rates as may be approved by the manager and directors of this company.

SEC. 13. *Be it further enacted,* That this act shall take effect and become a law immediately after its passage, and all acts or parts of acts in conflict herewith are hereby repealed.

Approved April 22, 1871.

N 10.

UNITED STATES ENGINEER OFFICE,
New Orleans, July 24, 1871.

GENERAL: I have the honor to transmit herewith a report from First Lieutentant E. A. Woodruff, Corps of Engineers United States Army, relative to the improvement of navigation of the Tchefuncte and Tangipahoa Rivers, in the State of Louisiana.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
New Orleans, Louisiana, July 12, 1871.

SIR: I have the honor to report that I have completed the survey of the Tchefuncte and Tangipahoa Rivers, in accordance with your instructions and order, dated April 20, 1871, and to submit the following reports thereupon, with maps of each river as far as surveyed.

The surveys being made with a view to determine the necessity or feasibility of improvements in the navigation of these rivers, are not extended above the head of navigation of each, viz: Covington, on the navigable branch of the Tchefuncte; and Wells' Ferry, on the Tangipahoa; but a reconnaissance of the latter river was carried to the mouth of the Tchappapeba, ten miles above Wells' Ferry.

TCHEFUNCTE RIVER.

This river empties into Lake Pontchartrain, near its most northern limit, and was, before the war, navigable as far as Covington, on Bogue Falaya, a navigable branch, joining the main river eleven and a half miles from its mouth.

The main river is not navigable above the junction of Bogue Falaya; its rapid current and tortuous course admitting only the smallest class of schooners and wood-barges, and these only for about three miles.

The entrance of the river from Lake Pontchartrain is good, requiring no improvement to admit any class of vessels likely to be needed for its commerce; 5½ feet is the minimum depth on the bar in front of the mouth, and at this season, owing to the crevasse on the Mississippi, and consequent high water on the lake, not less than 6½ has been found. Ascending the river, a broad and deep channel is found from the mouth to "The Old Landing," a distance of twelve and one-fourth miles. Up to this point, which is two miles from Covington, in a direct line, three miles by river, no important obstruction exists. The side-wheel low-pressure steamer Camelia, 180 feet long, drawing 5½ feet, and with wheels connected, makes the trip to "The Old Landing" twice a week; making all the bends at full speed either ascending or descending. The necessity for improvement, therefore, exists only between The Old Landing and Covington. Schooners still ascend to Covington, but this part of the river is closed to steamers of the class which ply on Lake Pontchartrain.

The obstructions are principally sunken steamers and shoals, with a few snags and leaning trees. Only two of the sunken steamers are any obstruction to navigation. These are the Oregon and the Bienville, the former two miles, and the latter one mile below Covington, by river. The Oregon was a side-wheel boat of 700 tons, formerly a mail-boat between New Orleans and Mobile. The Bienville was a confederate gunboat, built in Bayou St. John, and both were burnt to prevent their falling into the hands of the United States. Both are about 200 feet in length, and so covered with sand that their removal will be difficult. The Bienville lies close to one side of the channel, above a sharp bend in the river. The channel opposite the wreck is deep, but so narrow that a steamer would be in danger of striking the iron part of the wreck, some of which is above or near the surface of the water. The Oregon lies across the channel, leaving a passage only large enough for schooners. To open a channel for the steamboats would require the removal of about half of this wreck. For about 600 feet below the wharf at Covington the channel is narrow and shoal. To remove enough of this shoal to allow steamers to go to the wharf at all times would require about 10,000 cubic yards of dredging. Grant's Landing is only half a mile from Covington by road, and one and one-sixth by river. To reach Grant's Landing, by steamer, would only require the removal of the Oregon.

The estimate of the cost of making this river navigable to Covington is as follows:

Removal of the Oregon, (opening the river to Grant's Landing)	$6,000 00
Removal of the Bienville	2,000 00
Removal of shoals, dredging 10,000 cubic yards, at 50 cents per cubic yard.	5,000 00
Cutting down trees and removing snags	1,000 00
	14,000 00

Contingencies, 20 per cent	$2,800 00
Total	16,800 00

The estimate for removing the wrecks is based upon the actual cost of removing the boat Cotton from Bayou Têche. For the first wreck certain expenses must be incurred in the purchase of machinery, which can be used for subsequent work.

The expediency of any improvement of this river may well be questioned. Freshets cause considerable change near Covington, and these changes are assisted by the excavations of the banks for sand, to transport to New Orleans. The total result of the desired improvement would be to allow steamboats to go to Covington, (where schooners already go,) instead of stopping two miles and a half from the village. Covington contains less than a thousand inhabitants, and produces bricks, and a small quantity of lumber. Cotton, to the amount of about twenty-five hundred bales per annum, was shipped at this place before the building of the Jackson Railroad. The amount shipped at present is insignificant, but would probably be increased at the expense of the freight business on the Jackson Railroad and Pearl River if a daily line of boats was established.

The following is a table of the arrivals at New Orleans from Tchefuncte River, with kind and amount of produce received from the same, during the year ending July 1st, 1871. No accurate estimate of the exports from New Orleans to the Tchefuncte can be made, but the amount is probably less than the value of the produce of the river:

Total number of arrivals from Tchefuncte	710
Lumber, feet	2,928,000
Wood, cords	5,302
Sand, barrels	201,900
Bricks	1,400,000
Charcoal, barrels	43,290
Tar, barrels	709
Staves	242,000
Shingles	420,000
Cross-ties	700

TANGIPAHOA RIVER.

This river empties into Lake Pontchartrain on the north side, about nine miles west of the Tchefuncte, and three miles from Pass Manchac. There is no town or village on the whole of its navigable portion, which extends to Wells's Ferry, sixteen miles from the mouth by river, but only about seven miles in a direct line.

The lower ten miles of this river winds through an impassable cypress and gum swamp, valuable only for the timber which it produces. The six miles above the swamp (reaching to Wells's Ferry,) passes through a swamp bottom from one to five miles wide, bordered by pine barrens. The current is much more rapid than that of the Tchefuncte, and except at the season of lowest water, is so strong that even small schooners and wood barges have difficulty in ascending as far as Lee's Landing, the end of the first ten miles. Between Lee's Landing and Wells's Ferry the current increases rapidly, and at present, owing to shoals, rapid current, snags, fallen trees, and sharp bends, no attempt is made to take any craft above Collins's Ferry, fourteen miles from the mouth. The map, herewith submitted, shows the very crooked course of the river. Its winding is advantageous for two reasons: First, in checking the velocity of the current, which, if the river were straight, would be too strong for any vessel to stem; second, in opening a larger region of the swamp for the export of wood and timber. The obstructions in the river between the mouth and Wells's Ferry are snags, leaning or fallen trees, and shoals. There are no shoals, however, which will prevent the passage of vessels which can cross the bar at the mouth, except two, within two miles of Wells's Ferry; and these are caused by sunken logs or fallen trees, which a snag-boat could remove. Were the snags and fallen trees removed as far as Wells's Ferry, a small steamboat, drawing four and one-half or five feet, might be built to run to that place. Large quantities of cypress and pine timber are rafted from the upper part of the river and its principal tributary, the Tchappapela.

The value of this region for the supply of fuel for New Orleans is very great; and for raisins, fruit, and vegetables for the same market, the soil and climate are well adapted. The supply of brick material and sand is inexhaustible, and, as yet, entirely undeveloped.

During the past two years some emigrants from northern States have purchased the best part of the land in the vicinity of Wells's Ferry and the Tchappapela, and are making efforts to introduce various manufactures and improved agriculture. Although at Wells's Ferry the Jackson and Northern Railroad is but seven miles distant, there is a great desire among the people of that vicinity for such improvement of the river as shall enable them to reach New Orleans independently of the railroad, which is said to be oppressive in its charges on way freight. The only improvement practicable for this river is the removal of the snags and fallen trees, for which an estimate is submitted. Any attempt at dredging, or cutting off the numerous bends, the latter project being a favorite idea with some of the natives, would be worse than useless. The same snag-boat, or wrecking flat-boat, similar to the one now at work on Bayou Têche, might be used for both the Tchefuncte and Tangipahoa rivers.

Between Wells's Ferry and Black Bayou I counted twenty-two fallen trees, seventy-two leaning trees, and fourteen snags, which ought to be removed, if any improvement be undertaken.

As the river was at a comparatively high stage at the time of the survey of this part of it, the number of fallen trees and snags should be increased in an estimate, probably doubled. Below Black Bayou the channel needs no improvement, except in removing a few floating snags and sawyers. The improvement of the bar at the mouth would be too expensive for consideration. At present vessels drawing five and one-half feet can enter the river, and at a low stage of the water in the lake, four feet on the bar is said to be generally found.

Estimate of cost of removing snags and other obstructions in Tangipahoa River, below Wells's Ferry:

Cost of snag-boat with appliances and outfit	$2,500 00
Working expenses, four months, at $500 per month	2,000 00
Contingencies, twenty per cent	900 00
	5,400 00
If the same boat and machinery be used for Tchefuncte and Tangipahoa Rivers, one-half of the cost, viz	1,250 00
should be deducted, leaving	4,150 00

No data exists for giving information as to the amount of merchandise sent to the Tangipahoa River, but the following is a statement of the arrivals and exports from the river to New Orleans:

Number of arrivals, year ending July 1, 1871	169
Wood, cords	2,628
Shells, barrels	15,330
Cribs of timber	136

I remain, very respectfully, your obedient servant,

E. A. WOODRUFF,
First Lieutenant United States Engineers.

Captain C. W. HOWELL,
United States Engineers, New Orleans, La.

N 11.

UNITED STATES ENGINEER OFFICE,
New Orleans, July 24, 1871.

GENERAL: I have the honor to submit herewith a report by civil assistant Gustave Dyes, relative to the improvement of the channel from the mouth of Atchafalaya River, State of Louisiana, through Atchafalaya Bay, to the Gulf of Mexico.

Private enterprise has, for some time, been engaged in prosecuting the work, and an examination to determine the feasibility, value, progress, and cost of the plan adopted was considered all that was called for by my instructions from the Chief of Engineers.

Mr. Dyes approves the location given the channel, now being excavated; recommends it as a work of considerable value to commerce, and gives all the statistics needed for an estimate of its cost, completed, viz:

For channel 100 feet wide, 12 feet deep	$104,800 00
For channel 150 feet wide, 12 feet deep	122,300 00
For channel 200 feet wide, 12 feet deep	140,300 00

At the close of the work, there will remain on hand, dredges, scows, and tugs employed, the original cost of which is given at $69,300.

The time required for doing the work will be nearly as follows:

100-foot channel........	Working days of twelve and one-hours each. 1,100 cubic yards, each dredge.	152 days
150-foot channel........		228 days
200-foot channel........		304 days

The work is exposed to great delay from stormy weather, and it is, therefore, not possible to make more than the approximate estimate I have presented, which includes a large percentage for contingencies.

The work is located in the collection district of New Orleans, near the light-house at entrance to Atchafalaya River.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, United States Army, Washington, D. C.

NEW ORLEANS, LOUISIANA, *May* 25, 1871.

CAPTAIN: In compliance with your letter of instructions, dated April 20, 1871, I have completed a survey for a channel through Atchafalaya Bay, &c., and submit herewith my report, accompanied by a copy of a chart of 1858, United States Coast Survey, on which I indicate a line for channel.

The present channel leading from the mouth of Atchafalaya River into the Mexican Gulf through Atchafalaya Bay, now open to navigation for vessels drawing 12 feet or less, is very crooked, and subjected to sudden changes, which imperil navigation, and thereby destroy, to a great extent, commercial interests, which otherwise have a fair prospect of becoming rapidly and successfully developed. The data arrived at by sounding, taking the chart of United States Coast Survey of 1858 as a guide, would suggest the location of a new channel to connect the mouth of the river with the southwest reef-light channel, to be the one private parties are now engaged in establishing. It is the most direct one, changing its compass-bearing but once, from the river buoy to the light-house; following a direction where the formation of shell-reef and sand-bars offers the least dimensions as to width and shoalness; also assuming a course which the impetus of the current readily accepts.

The work of dredging this channel, now in progress, is carried on by three dredge-boats, built in accordance with the Osgood patent; one of them was brought here from New York, serving as a model, after which the other two were constructed. The model and one of the other two have a length of 70 feet, by 27 feet beam; the third one is 80 by 30 feet, all drawing 3½ feet water. Without being moved, these dredges are capable of excavating the width of their beam, and 10 feet headway, and 50 feet width of channel, without moving stern-anchors. For exposed work, similar to this in Atchafalaya Bay, 27 by 70 is more easily handled and therefore preferable. The scoop attached to a dipper of 45 feet length has a front depth of 6 feet, rear depth 3 feet, and 3 feet 8 inches by 4 feet bottom, with a raising capacity of 2 cubic yards; the length of the dipper admits of excavating a depth of 22 feet; runs over a cog-wheel to guide its depth, and a round table to determine its direction; the scoop is attached to the crane by a ¾-inch chain; the machinery is Philadelphia make, and its power 8-inch chain by 14-inch stroke. In fair weather, forty-four revolutions per hour is a good average for twenty-four hours, while the best working I observed in a calm day was one revolution in fifty seconds or seventy-two per hour, equal to 144 cubic yards. To remove the dirt so dredged, each dredge-boat has two dump-scows of a capacity of 80 cubic yards, drawing, loaded, 6 feet water, which are emptied by means of a tug, 400 yards north of channel at respective points, indicated by stakes. In fair weather, two dredge-boats employ the time of one tug, but as the heavy weather during winter and spring months requires almost constant repairing of machinery, one tug answered the purpose; this tug-boat has 3 feet draught forward by 5½ feet aft; tubular boiler, and twelve inches square cylinder.

In summing up the force employed in carrying on this work:

One steamship for superintendent and transportation of supplies.	
One tug to dump-scows..	$7,500 00
Three dredges, at $15,000..	45,000 00
Six scows, at $2,500..	15,000 00

One boarding-flat	$1,500 00
Three yawls	300 00
	69,300 00

The quantity of coal consumed during twenty-four hours is as follows:

Superintendent's boat, pounds	1,500
Tug-boat, pounds	1,500
Three dredges, pounds	9,600
	12,600
At $7 per ton	$44 10

The assistants on each dredge for night and day watch:

	Per month.
Two engineers, at $125	$250 00
Two firemen, at $60	120 00
Two dipper-tenders, at $60	120 00
Two deck-hands, at $40	80 00
Four scow-men, at $40	160 00
Two cooks, at $40	80 00
	810 00

Crew of tug per month:

Two engineers, at $100	$200 00
Two pilots, at $75	150 00
Two firemen, at $50	100 00
First and second mate, at $100 and $75, respectively	175 00
Six deck-hands, at $40	240 00
One cook, at $40	40 00
Two blacksmiths, at $75	150 00
Two carpenters, at $75	150 00
	1,205 00
Thirty-three men, cost of board, at 65 cents per day, per month	643 50

Estimating day and night equal to 20 working hours, an actual average during the winter and spring only gave 12½ hours.

12½ hours=88 cubic yards	1,100 cubic yards.
Or, 3 dredges	3,300 cubic yards.
Current expense, 3,300 cubic yards	$186 61¾

To this the running of superintendent's boat and crew has to be added, the expense of breakage, wear and tear, and interest on capital invested.

The following the officer in charge of the dredging-fleet permitted me to abstract from his log:

October.—19 days' work and 18 nights; 3 days' repair, dredge 1; 5 days Sunday; 4 days bad weather.

January.—16½ days' work and 15 nights; 8 days' repair and nights; 2¾ days bad weather; 4 days Sunday.

March.—20¾ days' work and 17 nights; 2½ days' repairs; 3¾ days bad weather; 4 days Sunday.

The entire distance of the channel to be excavated is 24,787 feet, of which 1,200 feet through oyster reef, (*a*,) 8,437 feet through sand-bar, (*b*,) have been accomplished for a depth of 12 feet.

Entire quantity to be removed	502,166 cubic yards.
Quantity removed April 28	195,238 cubic yards

This channel so excavated is only 100 feet wide, and to obtain a channel of a width of 150 feet, the quantity to be removed would be equal to 753,249 cubic yards.

The channel, in its present width, would require constant repair, as the banks are all the time more or less caving; having a width of 150 feet, the increased volume of water constantly washing through would materially ameliorate this, and it is my opinion that a width of 200 feet would require no repairs whatever, as (referring to above statement) the impetus of current naturally accepts the prescribed direction, and with this volume would entirely maintain its dimensions. Point au Fer Shell

Reef protects this channel from washing sand during southeast gales, and no structures of any kind would further secure its permanency.

The following is a list of exports and imports, obtained through the custom-house officer in charge of the district; the commercial interests influenced by existing facilities, as Brashear City for a port, are daily increasing, and it is the opinion of business men generally that the harbor and channel improvements now in operation will enhance the value of commerce for this section 300 per cent., which is probably an over-estimated opinion.

IMPORTS.

Pork	barrels.	4,800	Wool	bags.	25,000
Flour	do..	35,000	Pecans		2,500
Whisky	do..	2,500	Tongues		2,500
Potatoes		3,000	Horses		5,000
Bacon	cask.	2,000	Mules		1,500
Corned beef		2,000	Calves		10,000
Oats and corn	bags.	20,000	Sheep		10,000
Beeves		108,000	Hogs		25,000
Cotton	bales.	20,000	Sheep	skins.	30,000
Dry hides		104,000	Goat	do..	10,000
Wet hides		200,000	Wild	do..	15,000
Tallow	barrels.	6,000			

EXPORTS.

		1867.	1868.	1869.	1870.
Sugar	hogsheads.	3,260	8,300	12,100	22,750
Molasses	barrels	4,000	10,000	14,000	26,000
Cotton	bales.	8,000	12,000	17,500	30,000

Very respectfully, your obedient servant,

GUSTAVE DYES,
Civil Engineer.

Captain C. W. Howell,
Corps of Engineers, U. S. A., New Orleans, La.

N 12.

United States Engineer Office,
New Orleans, Louisiana, July 30, 1871.

General: Having completed an examination of Calcasieu Pass, State of Louisiana, in accordance with your instructions, dated Washington, D. C., March 15, 1871, I have the honor to submit the following report of its condition and commerce, and a project for improvement.

Calcasieu Pass connects Calcasieu Lake with the Gulf of Mexico, and is the outlet for the commerce of a considerable portion of Southwestern Louisiana.

Its entrance from the Gulf is practicable at all stages of the tides, for vessels drawing 5 feet or less, and does not require improvement. Its entrance from the lake is through the easternmost of two branches, and is closed at low tides to all vessels drawing more than three and a half feet, by a mud and shell bar, in length one and a half miles.

This bar is said to be the only obstruction to navigation existing between the Gulf and the town of Lake Charles, a place of local importance on Calcasieu River, about fifty miles from the Gulf of Mexico. Calcasieu River is reported navigable, at a good stage, to a point about sixty miles above Lake Charles.

Forty schooners, four steamboats, and one tug-boat are now employed on the river and lake, and running between the pass and Galveston. The schooners measure from 20 to 80 tons; the steamboats, 60 tons; these vessels draw from 3½ to 5½ feet, loaded.

Lumber is the principal export, and, in its preparation for market, gives steady employment to 15 steam saw-mills, 12 of which average a total of 120,000 feet per day, all of which goes to supply the demand from Texas. The greater part of this lumber has to be unloaded at the bar, rafted across, and then reloaded, an operation which involves much delay and expense. There are six ship-yards engaged in building small vessels suited to this trade.

Recently a company has been organized to develop the sulphur mines a short distance west of Lake Charles. Should the enterprise succeed, Calcasieu Pass will be the outlet for the product of these mines.

With this showing of the amount of commerce to be benefited, I think it proper to recommend a small appropriation for improving the bar at the head of the pass, so as to give a navigable crossing 5 feet deep at mean low tide.

The excavation of about 30,000 cubic yards will give such a channel, 80 feet wide and 1½ miles long, in a direct line, and for this I have estimated.

It is the opinion of my civil assistant, who made the examination, that a channel excavated, with the excavated material deposited at the sides, will remain open for several years.

The interests to be subserved are not great enough to warrant the expense of a more permanent work.

Should work be done at the mouth of Sabine River and the mouth of Trinity River, Texas, as I have recommended, the dredge-boat employed at those places can also be employed to advantage on this Calcasieu Bar for a sufficient time, say thirty working days, to make the channel. In that case, I estimate the expense of the excavation at $15,000. If it should be necessary to provide a dredge-boat especially for this work, $25,000 must be added to the estimate.

It is a matter of dispute among the captains of vessels engaged in navigating Calcasieu Pass as to the direction which should be given the channel, to be most favorable for its use. There will be time to consider this point after work is commenced. Whatever location is adopted will make no material difference in the cost of the work, as the length of excavation will not be greater than that on the line for which I have estimated. The incomplete manner in which the examination of the bar was made, obliges me to leave the location of a channel to be made when the work is commenced.

The United States light-house nearest this work proposed, is that at the entrance to Sabine Pass. There is a light-house at the entrance to Calcasieu Pass, maintained by private enterprise.

Very respectfully, your obedient servant,

C. W. HOWELL,
Captain of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

APPENDIX O 1.

Annual report of improvement of harbor and bay of Mobile, Alabama, for the fiscal year ending June 30, 1871.

By act of Congress approved July 11, 1870, the sum of $50,000 was appropriated for the improvement of the harbor and bay of Mobile, Alabama, to be expended under the direction and superintendence of the Secretary of War, according to such plans as should be by him first selected and approved.

By letter from the Chief of Engineers, dated July 20, 1870, Major C. B. Reese, Corps of Engineers, then in charge of this office, was directed to submit, at as early a day as practicable, a project for carrying on this improvement, &c. This project, and an estimate of its costs, were submitted to the Chief of Engineers, in a letter dated August 5, 1870, from Major C. B. Reese, and was as follows:

1st. To dredge out Choctaw Pass, Dog River Bar, and the channel above and below Dog River Bar, so as to give a channel which shall be 300 feet wide and 13 feet deep at mean low tide; the location of said channel to conform in the main to the route for vessels, as laid down on the United States Coast Survey Chart of 1856.

2d. To remove the upper and lower lines of obstructions, consisting of rows of piles, driven close to each other, and of sunken hulks, filled with bricks or other heavy material, so as to make the openings where the channel will pass through the obstructions 600 feet at the upper and 1,200 feet at the lower line.

3d. To prosecute the survey of the harbor, especially in reference to determining more definitely what are the obstructions which will require removal, and their exact positions; and also to determine, by soundings, the present depth of water down the proposed channel, until 13 feet of water at mean low tide is reached.

4th. Leave in abeyance and for future study the question of the propriety of closing any of the outlets of Mobile River, above Choctaw Pass, or of confining the current of the river in any way, with a view to producing a useful effect from scouring.

ESTIMATE.

	For dredging Choctaw Pass, to give 300 feet width of channel, and 11 feet of water at low tide:	
110, 000	cubic yards.	
	For dredging Dog River Bar, to give 11 feet of water, and width of channel as above:	
129, 000	cubic yards.	
	For dredging, to get 13 feet of water from the city to and across Dog River Bar, width of channel as above:	
516, 000	cubic yards, (exclusive of previous amounts.)	
	For dredging below Dog River Bar, to give 13 feet of water through to Lower Bay, width of channel as above:	
887, 000	cubic yards, (exclusive of previous amounts.)	
1, 642, 000	cubic yards, at 40 cents	$656, 800 00

The estimate for removing obstructions is omitted, as that work is being done by Mobile County. This project was approved by letter from Chief of Engineers, dated August 18, 1870.

An examination and survey were commenced in August, 1870, and, on the 6th of the same month, bids were invited for dredging the projected channel. Five bids were received, and upon their being opened September 7, 1870, that of Mr. John Grant, of Mobile, Alabama, being considered the most favorable, was accepted, the terms being 50 cents per cubic yard, excavation to be measured by soundings in the cut. September 20, 1870, Mr. John Grant commenced work with one of the Osgood dredges. On the 22d, Major C. B. Reese dying of yellow fever, the charge of operations devolved, temporarily, on Captain A. N. Damrell, Corps of Engineers, who was relieved by Colonel J. H. Simpson, Corps of Engineers, December 12, 1870.

On account of prevalence of yellow fever, the work was repeatedly interrupted, and up to December 1, 1870, only 5,839 cubic yards of material had been excavated.

The contractor, aware of the impossibility of complying with the terms of his contract with one dredge, built another one upon a plan of his own, which, however, proved a failure. The contract expired March 15, 1871, but application having been made under date of February 22 for an extension, which was approved, forwarded, and granted the 3d of March, 1871, the time stipulated for completion of contract was extended to June 30, 1871, and, in accordance with recommendation from this office, was further extended to August 31, 1871, by authority contained in letter from Chief of Engineers, dated June 28, 1871. The following statement will show progress of the work under the contract:

	Cubic yards.
Amount excavated to December 1, 1870	5, 839
Amount excavated to December, 1870, and January, 1871	10, 995
Amount excavated to February and March, 1871	9, 433
Amount excavated to April and May, 1871	8, 626
Amount excavated to June, 1871	3, 607
Total amount excavated to June 30, 1871	38, 500

Under date of December 26, 1870, a report was made by Colonel J. H. Simpson, Corps of Engineers, recommending a further appropriation of $200,000 for the continuation of the improvement.

In this report Colonel J. H. Simpson agrees with Major C. B. Reese, with regard to the direction of the proposed cut, but proposes a cut of 200 feet wide through Choctaw Bar, and 250 feet through Dog River Bar, instead of 300 feet in each case, as recommended by Major C. B. Reese, and estimates as follows, for amount and cost of excavation from accurate surveys and soundings made during the year:

1st. For dredging a channel 200 feet wide and 11 feet deep, at mean low water, through Choctaw Pass Bar, a length of 2,700 feet, average depth of excavation 3 feet:

60, 000 cubic yards.

Through Dog River Bar, a length of 18,400 feet, average depth of excavation 2¼ feet:

306, 666 cubic yards.

2d. For dredging a channel 200 feet wide and 13 feet deep, at mean low tide, through Choctaw Pass Bar, and 250 feet wide and 13 feet deep through Dog River Bar, as follows: Through Choctaw Pass Bar, a length of 3,200 feet, average depth of excavation 4¾ feet:

50, 615 cubic yards, (exclusive of previous amounts.)

Through Dog River Bar, a length of 38,290 feet, average depth of excavation 4 feet:

1, 111, 482 cubic yards, (exclusive of previous amounts.)

1, 528, 763 cubic yards, the cost of which I estimate as follows:

90,000 cubic yards, at 50 cents, agreeably to present contract, under appropriation of July 11, 1870	$45, 000 00
Balance of 1,438,763 cubic yards, at 45 cents, which it can doubtless be done for, if not for less	647, 443 35
But in order to obtain a clear passage through the two lines of obstructions, 450 feet of the upper line, consisting of three rows of piles, would have to be removed, estimated cost	10, 000 00
Also 400 feet of the lower line, consisting of five rows of piles, and sunken vessels, &c., estimated at	35, 000 00
Add 5 per cent. for contingencies and engineering	36, 872 17

Total estimated cost of making Choctaw Pass channel 200 feet wide, and Dog River Bar channel 250 feet wide, both to be 13 feet deep, and of removing obstructions	$774,315 52
Deduct present appropriation, which will be expended before the termination of present fiscal year, ending June 30, 1871	50,000 00
Balance yet required	724,315 52

From this total should be deducted $45,000 for removal of obstructions, which is being done by the board of harbor commissioners, with funds obtained by bonds issued by Mobile County, under an act of the State legislature, and also $50,000 appropriated by act of Congress approved March 3, 1871, leaving actual balance required at the present time, $629,315 52.

By act of Congress approved March 3, 1871, the sum of $50,000 was appropriated for this work. Under this act a contract has been awarded to Messrs. S. N. Kimball & Co., they being the lowest bidders, to excavate the Choctaw Pass channel to a depth of 13 feet below mean low tide.

The stipulated price is 39½ cents per cubic yard, measured by soundings in the cut. The necessary papers have been forwarded to this firm, executed, and their return is daily expected.

After the completion of the improvement, of the Choctaw Pass channel, the balance of the appropriation will be applied to the excavation of the channel through Dog River Bar, the contract of Messrs. S. N. Kimball & Co. embracing this portion of the work also.

An act of the legislature of the State of Alabama, approved in 1869, created a commission for the improvement of the harbor and bay of Mobile, and directed the county commissioners to issue county bonds to be applied to that purpose. The commission during the year has been duly organized, and demand has been made upon the county commissioners for bonds to the extent of $200,000. This board has co-operated, and have removed the upper line of obstructions, making a clear passage-way of 600 feet wide. They have also contracted for the removal of the lower lines of obstructions, and the work is now in course of execution, which has left the entire appropriation made by Congress available for payment of the cost of dredging.

A clear description of the nature of the improvement, and arguments in favor of the expediency of liberal appropriations and rapid prosecution of the work, is contained in the report of Colonel J. H. Simpson, of the 26th of December, 1870, to the Chief of Engineers, and it is, therefore, not considered necessary to reiterate.

An appropriation of $100,000 is asked for.

Amount appropriated by act of July 11, 1870		$50,000 00
Expended during 3d quarter, 1870, under the late Major C. B. Reese		597 30
Expended during part 4th quarter, 1870, under Captain A. N. Damrell		4,481 74
Expended during part 4th quarter, 1870, and August 1, and 2d quarter, 1871	$15,635 72	20,714 76
Amount available		29,285 24
Add appropriation of 3d March, 1871		50,000 00
Amount available June 30, 1871		79,285 24
Amount desired for year ending June 30, 1872		100,000 00

Respectfully submitted.

J. H. SIMPSON,
Colonel of Engineers, U. S. A.

O 2.

Annual report of examination and surveys under the charge of Colonel J. H. Simpson, Corps of Engineers, for the fiscal year ending June 30, 1871.

1. COOSA RIVER, ALABAMA.

By act of Congress approved July 11, 1870, the Secretary of War was directed to cause an examination or survey, or both, to be made at Coosa River, Alabama.

By letter from office of the Chief of Engineers, dated Washington, D. C., July 23, 1870, General C. B. Reese, major of engineers, at that time in charge of this office, was charged with this work, and was directed to inform himself of the nature and extent of the examination that might be required, and submit at an early day a project and estimate therefor, having regard to the strictest economy.

Project and estimate were submitted in letter of Major C. B. Reese, dated the 8th of August, 1870, to the Chief of Engineers. This project and estimate being approved, about the middle of August preparations were immediately begun to inaugurate the work, by ordering instruments and searching for an assistant to take charge of it. Henry C. Fillebrown was appointed to conduct the survey by Major C. B. Reese, on the 6th of August, and complete instructions for his work were given him at Mobile, Alabama, on the 24th of same month. Preparations were completed, and the survey and examination commenced at Wetumpka, Elmore County, Alabama, September 13, 1870.

On the 18th of September, Major C. B. Reese was attacked by yellow fever, and died at Shorts, Eastern Shore, Mobile Bay, Alabama, on the 22d of the same month. The charge of operations was then temporarily assumed by Captain A. N. Damrell, Corps of Engineers, under instructions from Chief of Engineers.

On the 12th of December, 1870, Colonel J. H. Simpson, Corps of Engineers, relieved Captain A. N. Damrell. The survey was pushed forward with all possible dispatch, until December 29, 1870, when the work was closed up for the season at the railroad-bridge of the Selma, Rome and Dalton Company, near Wilsonville, Alabama. The stoppage of the field-work at this point was rendered necessary by the high stage of water in the river, the winter rains having set in.

Under instructions from Colonel J. H. Simpson, Mr. Fillebrown discharged his party and repaired to Mobile, Alabama, and made out his preliminary report, which was finished and forwarded to the Chief of Engineers January 31, 1871. Since that date a map and tracing of the line of survey has been made, and the final report would have been finished and forwarded but for the fact that the difficulty experienced in obtaining competent assistants compelled the assignment of Mr. Henry C. Fillebrown to other duties during the greater portion of the time that has elapsed since he reported at this office. Under instructions from the Chief of Engineers, the charge of the Coosa River survey was transferred to Major Walter McFarland, Corps of Engineers, June 5, 1870.

Amount allotted from appropriation for the survey......	$4, 800 00
Expended under Major C. B. Reese, during third quarter, 1870..	678 98
Expended under Captain A. M. Damrell, during part of fourth quarter, 1870..	1, 442 62
Expended by Colonel J. H. Simpson, during part of 4th quarter, 1870, and 1st and 2d quarters, 1871..........	1, 914 57
Transferred to Major W. McFarland June 5, 1871.........	763 83
	4, 800 00

O 3.

UNITED STATES ENGINEER OFFICE,
Mobile, Alabama, February 2, 1871.

GENERAL: Although the survey of the Coosa River, authorized by the act of Congress approved July 11, and directed by you July 30, 1870, is not complete, the data on hand is sufficient to justify report on the subject and a further appropriation by Congress for the continuation of the survey.

The survey was commenced September 13, 1870, by Mr. Henry C. Fillebrown, under instructions from my predecessor, the late Major Chauncey B. Reese, Corps of Engineers, and continued till the 27th of December, when high water of the rivers covered the bars to such an extent as to make it inexpedient to continue it any further this season. Immediately thereafter an examination of the remaining shoal portion of the river was made, and below I have the honor to submit Mr. Fillebrown's report of this examination, all that is probably requisite for presentation to Congress at its present session. The report of the surveyed portion will be forwarded as soon as the maps can be prepared and the results worked out.

No appropriation is at present asked for the constructions necessary for the improvement of the river, for the reason that the survey necessary for the ascertainment of the best plan and cost of these constructions is not yet complete; but Mr. Fillebrown's report shows, with great force, that the project is entirely practicable, and, while this is so, *that there will be required for the completion of the survey the sum of* **$6,000**, *and an appropriation to this extent I earnestly recommend.*

The Coosa River (from an Indian word signifying "beautiful") takes its rise in Floyd County, Georgia, being formed by the junction of the Etowah and Oostenaula Rivers. Of these rivers, the Oostenaula only is navigable above the junction. Light-draught boats formerly plied between Rome at the junction and a point on the Oostenaula, ninety miles above, and the navigation could be readily improved so as to reopen that avenue of trade.

Pursuing a general course of south by west, the Coosa passes through the fertile counties of Floyd, Georgia, and Cherokee, Baine, St. Clair, (embracing the great Coosa coal-field,) Calhoun, Talladega, Shelby, Baker, Coosa, Elmore, and Autauga Counties, Alabama. Twenty-two miles below Wetumpka, Elmore County, and eighteen miles above Montgomery, the Coosa joins the Tallapoosa River, and the two combined form the Alabama.

The Coosa River is navigable from Rome, Georgia, to Greensport, Alabama, a distance of one hundred and eighty miles. Boats of 2½ feet draught can ply between those points throughout the year, and there is now a regular line of boats running from Rome, Georgia, to Gadsden, Alabama, one hundred and fifty-one miles below. There is no boat on the route between Gadsden and Greensport at present, as the amount of business does not justify it.

From Greensport, Alabama, to Wetumpka, a distance of about one hundred and forty miles, the navigation of the river is obstructed by reefs of rocks and gravel-bars.

The instrumental survey referred to was made between Wetumpka and the bridge of the Selma, Rome and Dalton Railroad, sixty-eight and a half miles above. The examination referred to was made of that portion of the river between the bridge and Greensport, a distance of about seventy miles.

It will be seen from Mr. Fillebrown's interesting and thorough report that the result of the examination spoken of above has been the suggestion of a system of improvements by which boats drawing 3 feet of water can run between Greensport and the Coosa bridge during the lowest stage. The result of the instrumental survey between Wetumpka and the bridge will be the demonstration of the fact that, by a similar system, a draught of 3 feet can be carried between those points also. This would give us an uninterrupted navigation from Rome, Georgia, to Wetumpka, Alabama, a distance of about three hundred and thirty miles, for boats of from 2½ to 3 feet draught.

The testimony of the pilots and steamboat men generally is to the effect that the Coosa River is always navigable from its mouth to Wetumpka whenever the Alabama River is navigable from Mobile to Montgomery. As it is very seldom that navigation is closed between Mobile and Montgomery because of the low stage of water, it is fair to assume *that the opening of the Coosa River to navigation between Wetumpka and Greensport will be the virtual opening of a channel for direct trade between Rome, Georgia, and Mobile, Alabama, via the Mobile, Alabama, and Coosa Rivers, by a water-course seven hundred miles in length, available at all seasons of the year.*

The opening and development of the rich and extensive coal and iron mines in the Coosa Valley will render this thoroughfare the great and important feeder of Mobile and the Gulf ports generally. The valuable products of the different counties bordering upon the Coosa River, which now seek a market over rough and circuitous roads, would naturally tend to this great highway; and the benefits of the great carrying trade thus created would be felt throughout the length of the river. Many products which are now neglected because of the difficulty of transportation would find a ready market and become a source of profit to the producer.

The report of Mr. Thomas Pearsall on the improvement of the Tombigbee River not having yet been submitted by him, I cannot, as I had hoped, forward it with this report. It will, however, be forwarded as soon as it is received.

I am, very respectfully, your obedient servant,

J. H. SIMPSON,
Colonel of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Mobile, Alabama, January 31, 1871.

GENERAL: Agreeably to your instructions, I submit the following report of my recent reconnoissance of that portion of the Coosa River lying between Greensport, Alabama, and the point where the Selma, Rome and Dalton Railroad crosses it some seventy-seven miles below.

At Greensport the Coosa has a width of 600 feet, with a channel-depth at the ferry of 46 feet. There is no current at this point, as the water of the river is backed up by the ledge of rock which extends across it at Whistenant's Mill shoal, one-quarter of a mile below the ferry. This shoal is in a depression of the rocky outcrops from two mountainous spurs, located on each side of the river, and consists of an almost perfectly straight ledge of rock running at right angles to the course of the river, and forming the connecting-link between the two mountains. At extreme low water this ledge is almost entirely bare, but near the eastern bank of the river a portion of it has been blasted off, and a passage-way, known as the "Boat Chute," excavated. Through this chute loaded flat-boats pass during the winter and spring months. Just below this rocky ledge is a bar, composed of loose round rocks and coarse gravel, which extends for 2,500 feet down the river, and laterally across it. Mr. C. M. Pennington, chief engineer of the Rome and Kingston Railroad, who made a survey at this point some years ago, gives the total fall at this shoal as 4½ feet. There is an outcrop of limestone on the east bank of the river at this point, which would supply excellent building material in any desired quantity. The ledges are so regular and the seams so well defined, that the stone could be quarried out in blocks already fit for the builder's use. Long-leafed pine, oak, and elm can be obtained in immense quantities on the slopes of the ranges of hills which border the valley of the river on each side. Lands on both sides of the river cleared and in good state of cultivation.

The improvement I would recommend at this point would consist in excavating a channel-way through the ledge, 50 feet in width, 4 feet in depth, and 500 feet in length, and building a dam at the lower end of the gravel bar. This dam would have a double effect, 1st, in changing the rapid to slack-water navigation by checking the velocity of the current; and, 2d, by backing up the water, and giving sufficient depth over the bar. Six feet would be a sufficient "lift" for the lock. An approximate estimate for the cost of this construction will be found in the accompanying paper.

Two and a half miles below Whistenant's Mill Shoal, we come to the head of the Ten-Island Shoal. This is a succession of shoals extending down the river for four and three-quarter miles, and consists of a series of rocky ledges and reefs supplemented by loose rocks and gravel bars. At the head of the shoal the mountains impinge upon the river, on either side, narrowing its width to about 600 feet. There are several small islands or tow-heads near the east bank, which are connected with each other and the main shore by a narrow but continuous ledge of rock, forming a perpendicular fall of one foot. The deepest water is next the west bank, where the boat-chute channel has been excavated through the ledge. Immediately below this point the land on the east bank flattens out, and is cultivated in cotton, corn, and wheat, but on this west bank there are no clearings for some distance down the river. Rock crops out all along the hillsides, until we reach a point one-quarter mile below the "Narrows," where there is a perfect mountain of sandstone. About one and a half miles below the head of the shoal a reef of rocks makes out from the west bank, and extends nearly across the river at right angles to its course. This reef flattens out as it nears the east bank, and changes its character to that of a loose rock bar mixed with heavy gravel. This bar extends down the river for about three-eighths of a mile, the reef proper being about 100 feet in width. At this point the river is about 900 feet wide, but increases in width to about 1,500 feet as we go down the shoal, forming a wide bay about two and a half miles below the head, and at this point there are four islands lying nearly abreast of each other, and dividing the river into five nearly equal channels. Three of these islands are small, containing from 5 to 8 acres each, while the fourth, known as Wood's Island, is about one and a quarter miles long, and contains about 160 acres, mostly cultivated. One-quarter mile below the head of this bay a point makes out from the east bank of the river, forming first a reef and then flattening out into a shoal next the east bank of Wood's Island. Greatest depth of water is next the west bank. Just below this reef the river is clear of obstructions, the only drawback to navigation being the rapid current. At the lower end of Wood's Island the river is about 800 feet wide, and the navigation is good down to Miller's Ferry, one and a half miles below. Tallassechatchie Creek empties in from the east just at the upper side of the ferry. The aggregate fall from the "Narrows" to the extreme lower end of the Ten-Island Shoal is given by Colonel Pennington at 12 feet; but as he did not make an instrumental survey, I suggested that it would be best to guard against a possible error of judgment by providing for a fall of 16 feet. I would propose the erection of three dams, to be located at about equal distances apart, between the head and foot of the shoal. The dams should be each 6 feet above low water. It would also be necessary to clear a channel-way between the locks. An approximate estimate of the extent and cost of the dams, &c., will be found in the accompanying paper. In suggesting the erection of three dams, I have been governed by a desire to avoid damage to private parties which might ensue from the overflow of their lands caused by the erection of higher dams. A regular instrumental survey may demonstrate the fact that the fall is not so great as is estimated, and that two dams, a little more elevated, say to 7 feet each, might effect the desired result. The average length of these dams will not exceed 1,000 feet, and if they are judiciously located and proper advantage taken of the small islands, it may very possibly be found that wing-dams, or dams connecting one or more of the islands with the main shore, would answer all the purposes of a permanent improvement, and effect the desired result with the advantage of greatly diminished cost. Stone in any desired quantity and of good quality can be obtained immediately upon the west bank of the river, while the hills which skirt the bottom-lands on the east bank will afford an almost unlimited supply of timber of the finest quality.

About eight hundred feet below Miller's Ferry we arrive at what is known as Miller's Shoal. This consists of a narrow, rocky reef, extending from the east bank across the river, with the exception of an opening, about 30 feet wide, next the west bank, known as the Boat Chute. The only improvement necessary at this point would consist in widening the channel-way to 60 feet. The owner of the ferry states that there is 2¼ feet water through the chute at the lowest stage, while he has 36 feet of water in the channel at his ferry. Estimate of extent and cost of improvement at this point will be found in accompanying paper.

From this point down to Box Shoal, twenty-five miles below Greensport, there is good navigation, with the exception of some loose rocks, at two points, which will require removal. Estimate of extent of work and probable cost will be found herewith.

Leaving the river, I went out and visited the coal-field in the vicinity of Box Shoal. Examined six pits, which were abandoned and partially filled with water. I was informed that they were no longer worked because they had no means of transporting their coal to a market, nor had they the necessary capital. I find that in one case the drift had been carried back into the hill over 1,000 feet. Thousands of tons of coal have been mined in this locality and shipped to Montgomery, Alabama, in flat-boats, but owing to the dangerous character of the shoals in the lower part of the river, they usually lost one boat by wrecking out of every three dispatched. When mining operations were carried on here, it cost but from 18 to 20 cents per ton to raise the coal, whereas at present prices of labor it would cost about $1. The seams vary in thickness from 2½ to 5 feet, and the hills in this vicinity appear to be completely underlaid by the different strata. The specimens examined were of excellent quality, and the quantity seemed inexhaustible. Iron ore abounds, also sand and lime stones, while the hills are covered with an excellent growth of oak and pine. Within half a mile of the pits visited, there is a considerable hill, which appears to be almost entirely composed of red hematite ore. The owner of this property claims that the ore yields, by actual analysis, 65 per cent. of pure iron. There is no indication that any attempt has ever been made to take advantage of this deposit by the erection of furnaces, &c.

Box Shoal consists of a low flat ledge of rock running across the river at right angles to its course, while immediately above and below the ledge is a bar composed of loose rock and coarse gravel. Next the east bank is the boat-chute, which is either situated in a depression of the rock, or else a channel-way has been excavated through it. This channel should be both widened and deepened, and a passage excavated through the gravel bar above and below, sufficiently wide to admit of free navigation. Stone and timber for building purposes to be obtained in abundance on the west bank, which is bluff for 80 feet in height. On the east bank we have fine bottom-land, which is sufficiently elevated to be above overflow at the highest stage of water. A crib-work canal, with masonry, heading and tailing for the lock-chamber, with a lock-lift of 5 feet, would be amply sufficient, in connection with the excavation recommended above, to meet the requirements at this point. The canal should be 600 feet in length. Estimate of cost of the proposed construction to be found in accompanying papers.

Two miles below Box Shoal we come to Broken Arrow Shoal. The upper end of this shoal consists of a gravel-bar extending across the river, with 2 feet water on the west side, and about 3 feet on the east. About 400 feet below this bar there are two islands lying nearly abreast of each other. The one near the west bank is about 2,000 feet in length, and the channel-way between it and the main shore is about 120 feet in width. The distance between the islands is about 250 feet, and the distance between the second island and the east shore is about 400 feet. Total width of river, 1,200 feet. There is a sufficiency of water in the channel I passed through, (next the west bank,) but it is narrow. Island No. 1, at its lower end is merely a narrow strip of land, overflowed during high water. No. 2 is wider, and about 2,500 feet long. At the lower end of Island No. 2 there is another gravel-bar, extending across the river, and having but 7 or 8 inches water over it, except near the east bank, where there is a tolerably good passage-way for boats going down stream, but a considerable current. Immediately below this bar the river narrows into a width of about 850 feet near the foot of Island No. 1. Broken Arrow Creek empties in from the west. This stream is about 70 feet in width at its mouth, with steep banks, and must supply a very large volume of water during the spring of the year. Near this point the west bank of the river shows indications of coal, and there is a partial outcrop of a seam just above the mouth of the creek. It is claimed that coal has actually been taken from the bed of the river in this locality, and shipped by flat-boats to Montgomery, Alabama, in considerable quantities.

A passage-way 500 feet in length, 60 feet in width, and 3 feet in depth, excavated through each of the bars referred to above, would be sufficient to insure good navigation, if, in addition, we provide against the velocity of the current.

Four thousand feet below the foot of Island No. 2 there is another bar, extending nearly across to the east bank, and having only 18 inches of water over it. In this, as well as the previous instances, the best water is next the east bank. An excavation similar to those suggested for the upper bars will be necessary in this case. A peculiarity in these shoals consists in the fact that the banks, which are comparatively low and level on each side of the river, afford no evidence that the bars are the result of outcrops of any formation near the river. Both banks of the river are cleared and cultivated, and the outlying hills are covered with a good growth of pine and oak. The length of the Broken Arrow Shoal is about three miles, with a total fall in that distance of about 10 feet. Two dams will be amply sufficient to overcome the fall, check the velocity of the current, and back up the water sufficiently to insure good navigation. Location of the dams to be determined by actual survey. Estimate of cost of the proposed improvement will be found in accompanying paper.

From the foot of Broken Arrow Shoal to the head of Robertson's Shoal, a distance of nine miles, the navigation is only interrupted by some loose rocks. These could be removed at a cost not exceeding $2,500 for the entire distance.

At the head of Robertson's Shoal there is an island about 1,000 feet in length, near the east bank, and connected with it by a gravel-bar. The shoal proper consists of a reef of loose, broken rock, extending from the head of this island across to the west bank. There is a boat-chute cleared through this reef, and the judicious expenditure of $2,500 will pay for widening and deepening it so as to afford good and safe navigation at all seasons of the year. The island spoken of above is about 400 feet wide, and the extreme width of the river at this point is about 1,600 feet.

True's Ferry is situated at the lower end of the island, and the river at that point is 1,180 feet wide. This is the crossing-point for the travel between Asheville and Talladega, the county seats of St. Clair and Talladega counties, and there is the nucleus of a town here called Ferryville.

One mile below Ferryville we arrive at the head of Choc-o-loc Shoal. At this point the river makes a considerable bend to the westward and widens out to 1,500 feet. The shoal consists of detached reefs of rocks, with openings through them in every direction, but too irregular in location to admit of the passage of a steamboat. The boat-chute is located near the west bank, and there is a tolerable good passage-way along it, but the isolated rocks just beneath the surface of the water render it impracticable, in its present state, for steamboat navigation. With the exception of a few isolated rocks, we have a mile of good water below the shoal. The river then widens out to 3,000 feet, with Castleberry's Island (containing about 68 acres of land, 40 of which are under cultivation) about 400 feet from the east bank. Heavy gravel-bars make out from the west side of the island, but appear to break off before reaching the main shore. Choc-o-loc Creek empties in from the east about half-way down the island. Just below Castleberry's, the river narrows in again to a width of about 1,200 feet, with a small island, about 300 feet long, next the east bank. Good water along the west bank of the river, with a current not exceeding one and a half miles per hour. Banks of the river heavily timbered with oak and elm.

The improvement suggested for Choc-o-loc Shoal would consist in clearing a channel-way through the reef at the head, and removing, by blasting, the isolated rocks referred to. I consider that it would be necessary also to build a dam 9 feet in height, to check the velocity of the current and give additional depth in the wider portions. Location of the dam, which would be about 1,100 feet in length, to be determined by actual survey.

From the foot of this shoal, which is about four and a half miles below Ferryville, to Collins's Ferry, which is four and a half miles farther down, we have a good river. At Collins's Ferry the river is about 1,000 feet wide, with deep water. Bottom-land on both sides, but the hills are only from 300 to 400 yards back from the river. On the west side the hills are covered with a fine growth of long-leafed pine, while on the east side the timber is more varied in character, consisting of oak, pine, and elm. Limestone in abundance in the hills. Two and a half miles below Collins's, the hills on the east bank spur out on the river, and the limestone crops out all along their sides. At the upper end of the bluffs is a kiln in active operation. River narrows in at this point to a width of 450 feet, with deep water. Land cultivated on both sides of the river. One mile and a half below this "narrow," the river widens out to about 1,300 feet, with a small island located about the middle of the river. From the head of this island a gravel-bar extends across toward the west bank, with but 18 inches water on it, but the bar is narrow and does not extend down the river more than 300 feet, and the water below it is 3½ feet deep at the present stage. The reach below this bar was described to me by Captain Coulter, of the steamboat Etowah, as being "a long shallow reach, along which you will find about 3½ feet of water at the present stage, and which you would be inclined to report as good water, but in the lowest stage there is but from 14 to 18 inches along its whole length, which is about three miles." I found his statement regarding the depth to be correct, as my frequent soundings showed a uniform depth of 3½ feet. The island spoken of as being at the head of this shoal is about 1,800 feet long, and at its foot the river again contracts to a width of 850 feet. A passage-way should be cut through the bar at the head of the island. An excavation 200 feet long, 60 feet wide, and 3 feet deep would be sufficient. A dam 8 feet in height, at the foot of the reach, would be required to back the water up over the shallows and give a uniform depth of at least 3½ feet at the lowest stage. Estimate of cost furnished herewith.

Just below this reach the river widens out to 2,000 feet, at a point known as the head of Claunchy's Shoal, which consists of a wide gravel-bar, interspersed with large loose rocks, and 3,000 feet below this bar is a reef of rocks extending across the river and causing a fall of 1 foot. Half a mile below this reef we come to Robinson's (formerly Freeze's) Ferry, and 1,000 feet below the ferry-landing is another reef making out from the east bank, but breaking off before it reaches the west shore. One mile below the ferry is Drake's mill, located on the west bank of the river. A reef just above the mill forms a portion of the wing-dam which supplies it with water. This reef extends diagonally up the river, and in the angle formed by it is a heavy gravel-bar. From the mill across the east bank there is an irregular reef of rocks, many points of which are above water, it being composed of large detached rocks. The width of the river at this point is about 1,900 feet, and the proprietor of the mill, Mr. Drake, informed me that the river was fordable, horseback, during the low stage, just below the reef, the water being at that time about 3 feet in depth. This shoal extends for a distance of three-fourths of a mile below the mill, and presents the same characteristics throughout its entire length. Large detached rocks, with gravel and loose rock-bars constitute the obstructions. A channel-way can be excavated along the east bank, and 200 feet distant from it. The advantage to be gained by this location of the channel-way consists in the fact that the boat-chute passes along there and affords the best water. Total length of Claunchy Shoal about two and a half miles.

The improvement suggested for this locality would consist in cleaning out and widening the channel-way through the three main reefs, and removing detached rocks from the channel-way along the east bank. The current over and just below these reefs being quite strong, it would be necessary to construct dams to check the velocity, and, by backing up the water, give additional depth. The total fall throughout the length of the shoal will probably amount to 12 feet, and it will be necessary to build two dams, each 8 feet in height, to be located by actual survey. The excavations necessary will average 500 feet in length, 60 feet in width, and 3 feet in depth. Stone and timber of good quality and in any desired quantity to be had at hand. Estimate of cost herewith.

At the foot of Claunchy's Shoal the river narrows into a width of 1,000 feet, and makes a strong bend to the westward, while the hills on the east side come in bluff to the river. Two and a half miles below Drake's mill we arrive at Turner's old mill shoal. The river between these points is in good navigable condition.

Opposite Turner's old mill there is a shoal which extends down the river for about three-quarters of a mile. This shoal consists of a heavy gravel-bar, with some boulders of limestone. The bar extends from the head of a small island, near the east bank, diagonally across the river. The boat-chute is located in a depression of the bar, near the west bank.

The improvement necessary at this point would consist in widening and deepening the boat-chute, as the channel for portions of the distance along this shoal is perfectly good. The excavation and dredging necessary would embrace different portions throughout the length of the shoal, rendering it difficult to make a condensed estimate of the cost. I am of the opinion, however, that the judicious expenditure of a sum not exceeding $7,000 would suffice to secure good navigation at the lowest stage of water. There is but one point where the gravel-bar extends to the west bank, and the current is not strong enough to prevent a steamboat from making good headway against it.

At the foot of Turner's Shoal the river again narrows to a width of 800 feet. The west bank of the river spreads out into a wide bottom, elevated about 10 feet above high water. One mile below the foot of the shoal there is a large island, lying next the east bank. This island is about 1,500 feet in length, with an average width of 200 feet, cultivated. The best water is between the island and the west bank, the width of channel-way being about 550 feet. Half a mile below this island the river bends to the eastward, with bottom-lands on both sides, and then makes a straight course for two miles. At the end of this stretch we come to a shoal 1,000 feet in length, which consists of a gravel-bar extending across the river. Rapid shoal water for 800 feet, and then another gravel-bar. A channel-way should be excavated through these bars, and a dam 8 feet in height constructed at a point a quarter or half a mile below the lower bar. This would insure sufficient water over the shallows. The excavations necessary for the bars would be each 200 feet in length by 60 feet in width, and 3½ feet deep. The dam would be 900 feet in length, and the necessary material is near at hand. Two miles below this shoal we pass the mouth of Kelly's Creek, making in from the westward. Creek is 125 feet wide at its mouth, with high banks.

One thousand feet below the mouth of Kelly's Creek, we arrive at the head of Ratcliff's Shoal. This consists of an irregular reef of rock running diagonally across from the west to the east bank. A passage-way next the west bank can be secured by making an excavation 200 feet long, 100 feet wide, and 3½ feet deep. This will give ample room and water. At a point three-quarters of a mile below this reef an excavation 400 feet long, 100 feet wide, and 3½ feet deep will be required. These reefs are respectively located at the head and foot of Ratcliff's Island, which is about 3,500 feet long and contains 36 acres, 25 of which are cultivated. Half a mile below the island we come to Glover's Ferry. River at this point 800 feet wide and very deep. Spring Creek, 50 feet wide at its mouth, makes in from the west just at the Ferry.

Two miles below Glover's Ferry we arrive at the head of Hall's Island Shoal. This consists of a gravel-bar, running from the west bank across to the head of Hall's Island. An excavation (all gravel) 600 feet long, 100 feet wide, and 3 feet deep will be necessary at this point. Hall's Island is narrow, covered with cane, and is about 3,500 feet long. Passage-way between the island and west bank 400 feet wide. Banks of the river cleared and cultivated. It will be necessary to clear out some snags at the foot of the island and near the west bank; $500 will cover the cost.

One mile and a quarter below Hall's Island, about one-fourth mile above Clear Creek, which comes in from the eastward, is another gravel-bar, which will require an excavation 350 feet long, 100 feet wide, and 3 feet deep, to give an ample passage-way. River at this point is 900 feet wide; banks cleared and cultivated. Clear Creek is 40 feet wide, with high banks. From this point down to Kimulga Ferry, a distance of four miles, we have a beautiful river, with plenty of water. Kimulga Creek, 80 feet in width, with high banks, empties in from the east just at the upper side of the ferry.

One mile below Kimulga we come to Talladega Creek, making in from the eastward. This creek is about the same size and volume as Kimulga. From the upper side of the mouth of this creek a reef of rocks runs diagonally across the river. An excavation 200 feet long, by 100 feet wide and 3 feet deep, will be necessary to secure a good channel-way along the west bank. There is very little current.

One mile below the mouth of this creek we come to Booram's Island, lying nearly in the middle of the river. This is the proposed location of the bridge of the Opelika and Tennessee River Railroad Company. The island is about 3,000 feet long and 350 feet wide in the middle. Banks of the river about 9 feet above extreme high water on either side, and the island is about the same elevation. The character of construction proposed for the bridge is unknown; none but a draw-bridge should be constructed, and the draw should be between the island and the west bank of the river. Extreme width of the river, midway of the island, is about 1,500 feet, and at the foot of the island it contracts to about 1,000 feet, and maintains that general width down to the bridge of the Selma, Rome and Dalton Railroad Company, some six miles below. Good navigation for the entire distance.

The bridge of the Selma, Rome and Dalton Railroad Company is a wooden structure of the Howe truss pattern. Total length of bridge, 869 feet; five spans averaging 173.8 feet each, supported by five piers of hard limestone. Abutments on either side, 20 feet deep. Floor of bridge, 22 feet above high water. Average depth of water, 11 feet. The superstructure of this bridge requires renewal, and it would be necessary to change the character of its construction, by making it a draw-bridge. The draw should be located next the east bank, as there is a depth of 13 feet under the first span on that side.

At Coosa bridge (described above) I connected with the survey made from Wetumpka, Alabama, to that point. A report, in detail, of the operations and results on the lower portion of the river will be furnished you as soon as the data can be worked up and the proposed plans of improvement discussed.

I respectfully call your attention, General, to the almost absolute necessity existing for a thorough instrumental survey of that portion of the Coosa River described above, in order that a full report may be made regarding the whole river. Having carefully examined the topographical features during my recent reconnaissance, I am satisfied that the survey can be completed for a sum not exceeding six thousand dollars.

In my report of my recent survey of that portion of the Coosa River between Wetumpka, Alabama, and the Coosa bridge, I trust to be able to demonstrate the practicability of improving the navigation between those points so as to insure safe transit during the lowest stage of water.

I think, General, that the importance of the proposed improvement, namely, opening up the Coosa River throughout its entire length, is ably argued in the letter addressed by Major Eugene Le Hardy, chief engineer of the Selma, Rome and Dalton Railroad, to the "Commercial Convention," which assembled at Louisville, Kentucky, two years ago. I take the liberty of quoting a few paragraphs:

* * * * "The distance between Rome, Georgia, and Mobile, Alabama, is seven hundred miles or thereabouts.

"2d. The difference of level between low water at Rome, Georgia, and the tide-water of the Gulf, is 590 feet, giving a general slope per mile of foot 0.81.

"3d. The upper and navigable portion of the Coosa River, from Rome, Georgia, to Greensport, Alabama, is one hundred and eighty miles.

"4th. The lower portion of the Coosa River, partly shoaly, partly navigable, between Greensport and Wetumpka, is one hundred and thirty-four miles, with a difference of level of 244.5 feet, or an average fall of foot 1.84 per mile.

"5th, The distance between Wetumpka and Mobile, also navigable in all seasons, is three hundred and eighty-six miles.

"6th. Summing up the two portions navigable, make five hundred and sixty-six miles, and their whole fall is 345.5 feet, which gives an average of foot 0.61 per mile.

"From these features we can see at once that the technical question, or the apportionment of the fall by a judicious and skillful construction of bars and locks, present no material difficulty, and that the amount of money required to do that work is a matter of very small importance, if we consider the magnitude of the advantages to be attained. The wonder is that this work has not been accomplished a long time ago.

Indeed, what channel of transportation is better calculated than this, to spread all around industry, prosperity, and wealth?

"The valley through which it runs abounds in coal and iron ores of the best qualities, marbles of various kinds, fire-proof stone, lithographic stone, gray and sand-stones, and a variety of minerals. Capital and cheap transportation only are wanted to make this section of country an immense workshop, capable of giving employment to thousands of mechanics and workmen, and turning out every year millions of dollars' worth of products of all descriptions.

"The ports of the Gulf of Mexico, now supplied with English and Pennsylvania coal and iron, ought to be furnished direct from the banks of the Coosa River; so also the West Indies, Central and South America.

"Professor Toumey, on page 76 of his Report on the Geological Survey of Alabama, speaking of the Coosa coal-fields, says: 'This coal has been carried down the Coosa River to Montgomery, where it has been sold for 40 cents per bushel. But what gives it its greatest value here, is its vicinity to a good bed of iron ore, which it approaches within a distance of two miles. There are here, then, within a space of a few miles, all the materials for the manufacture of iron ore, coal, limestone, and fire-proof stone, and on the immediate bank of the river.'

"Judging from the experience in every country under similar circumstances, what an immense economical revolution this new channel of communication by thorough transportation, once opened, must produce in the country at large, and particularly in the States of Alabama and Georgia, immediately contiguous.

"The climate of the Coosa Valley is salubrious, mild, and temperate, its winters of short duration, its soil rich, and producing, besides the staples, everything in abundance which is necessary to make living cheap for the workman, laborer, and mechanic. This great valley is intersected by a large number of streams which never freeze, and on them a multitude of sites for mills and factories, with inexhaustible water-power, and all destined one day to be the customers and feeders of this great channel.

"For want of this great thoroughfare, millions of dollars' worth of the best long-leafed pine, a great variety of oak, ash, walnut, cedar, cypress, and poplar, which could be turned into the best lumber for construction and other purposes, are now reduced to ashes or rot upon the ground.

"If we take a belt of twenty miles distance on each side of the river, at which the effect will be felt materially, we find an area of 28,000 square miles, or 180,100,000 acres of land, of which the United States Government owns several millions in the shape of public lands."

It is almost impossible to estimate the increase in value of these lands which will be the natural and immediate result of opening the river to navigation. It is fair to suppose, however, that the increase will be many times greater than the amount necessary to pay for all the required improvements.

Accompanying this, I respectfully submit approximate estimates of the extent of work, and cost thereof, necessary, in my humble judgment, to open up the Coosa River between Greensport, Alabama, and Coosa bridge.

Again respectfully calling your attention to the necessity of completing the survey of the Coosa River,

I remain, general, with great respect, your obedient servant,

HENRY C. FILLEBROWN,
Civil Engineer, Coosa River Survey.

Brevet Brigadier General J. H. SIMPSON, U. S. A.,
Colonel Corps of Engineers, Mobile, Alabama.

Estimate of amount of work required, and cost thereof, to remove the obstructions to navigation in the Coosa River between Greensport, Alabama, and the point where the Selma, Rome and Dalton Railroad crosses the river, some seventy-seven miles below.

The character of construction recommended for the dams and canals, with their lock-chamber, consists of crib-work made of timber, 14 inches in diameter, filled in with heavy rock and doubly planked with 2-inch plank, the heading and tailing of the locks to be of mortar-laid masonry where the material is at hand.

Prices of work based upon the schedule of prices paid by the different railroad corporations in the immediate vicinity.

Assuming as a general rule that each dam will have a base of 20 feet, with perpendicular height of 10 feet, it will require for each running or lineal foot of dam—

69 lineal feet of timber, at $3 50 per 100 feet	$2 42
136 feet planking, at $10 per M feet	1 36
3½ yards loose rock for filling, at $1 12½ per yard	3 93

Labor, cutting and filling mortises and tenons, and putting material in place, per lineal foot	$3 50
	11 21
Add for engineering expenses and contingencies, 30 per cent	3 36
Total estimated cost, per lineal foot, of dam	14 57

Average cost per cubic yard of masonry	$8 00
Hard rock excavation, per cubic yard	1 50
Loose rock excavation, per cubic yard	75
Gravel excavation, per cubic yard	75

Whistenaut's Mill Shoal:		
Dam 1,000 feet long, at $14 57 per foot	$14,570 00	
Locks, 370 cubic yards of masonry, at $8	2,960 00	
Rock excavation, 3,704 cubic yards, at $1 50	5,556 00	
		$23,086 00
Ten Island Shoal:		
Three dams, each 1,000 feet long	43,710 00	
Locks, 1,110 cubic yards masonry, at $8	8,880 00	
Rock excavation, 2,133 cubic yards, at $1 50	3,199 50	
		55,789 50
Miller's Reef:		
Rock excavation, 889 cubic yards, at $1 50		1,333 50
Loose rock at two points between Miller's Reef and Box Shoal, $1,500 each		3,000 00
Box Shoal:		
Locks, 370 cubic yards masonry, at $8	$2,960 00	
Crib-work, canal, (same dimensions as dam,) 1,200 feet	17,484 00	
Rock excavation, 900 cubic yards, at $1 50	1,350 00	
Loose rock and gravel excavation, 2,433 cubic yards, at 75 cents	1,824 75	
Estimated cost of dredging above and below shoal	2,000 00	
		25,618 75
Broken Arrow Shoal:		
Two dams, each 900 feet long, 1,800 feet, at $14 57	26,226 00	
Loose rock and gravel excavation, 8,000 cubic yards, at 75 cents	6,000 00	
		32,226 00
From foot of Broken Arrow Shoal to head of Robertson's Shoal, some loose rock to be removed, at an estimated cost for entire distance of		2,500 00
Robertson's Shoal:		
Estimated cost of widening and deepening the boat-chute at this point		2,500 00
Choc-o-loc Shoal:		
Dam, 1,100 feet long, at $14 57	$16,027 00	
Rock excavation, 2,500 cubic yards, at $1 50	3,750 00	
		19,777 00
Bar 8¼ miles below Choc-o-loc:		
Loose rock and gravel excavation, 1,333 cubic yards, at 75 cents		1,000 00
Foot of Long Shallow Beach:		
Dam, 1,000 feet long, at $14 57	$14,570 00	
Claunchy's Shoal:		
Two dams, each 1,000 feet, 2,200 feet, at $14 57	32,054 00	
Rock excavation, 16,667 cubic yards, at $1 50	25,000 00	
		57,054 00
Turner's Mill Shoal:		
Total estimated cost of widening and deepening the present channel		7,000 00
Four miles below Turner's Shoal:		
Dam, 900 feet long, at $14 57	$13,113 00	
Loose rock and gravel excavation, 3,111 cubic yards, at 75 cents	2,333 25	
		15,446 25
Ratcliff's Island Shoal:		
Loose rock and gravel excavation, 7,778 cubic yards, at 75 cents		5,833 50
Hall's Island Shoal:		
Loose rock and gravel excavation, 6,667 cubic yards, at 75 cents	$5,000 25	
Removing snags near foot of island	500 00	
		5,500 25

Clear Creek Bar:	
Loose rock and gravel excavation, 3,889 cubic yards, at 75 cents	$2,916 75
Talladega Creek Bar:	
Rock excavation, 2,222 cubic yards, at $1 50	3,333 00
Total estimated cost	278,484 50

Respectfully submitted.

HENRY C. FILLEBROWN,
Civil Engineer, Coosa River Survey.

O 4.

2. EXAMINATION AND SURVEY OF THE TOMBIGBEE RIVER, ALABAMA.

By act of Congress approved July 11, 1870, the Secretary of War was directed to cause an examination or survey, or both, to be made of the Tombigbee River, in Alabama and Mississippi, from its mouth to the head of navigation.

By letter from office of the Chief of Engineers, dated Washington, D. C., July 23, 1870, Major C. B. Reese, Corps of Engineers, at that time in charge of this office, was charged with this work, and was directed to inform himself of the nature and extent of the examination that might be required, and submit at an early day a project and estimate therefor, having regard to the strictest economy, &c.

A project and estimate were submitted in letter of Major C. B. Reese, dated the 8th of August, 1870, to the Chief of Engineers. This project and estimate being approved about the middle of August, preparations were immediately begun to inaugurate the work, by ordering instruments, and searching for an assistant to take charge of it.

Thomas Pearsall being highly recommended by prominent parties as a man competent for the position, was promised the appointment by Major C. B. Reese, Corps of Engineers, on the 13th of September, 1870. On the 18th of September, Major C. B. Reese was attacked by yellow fever, and died at Shorts, Eastern Shore, Mobile Bay, Alabama, on the 22d of same month. The charge of operations was then temporarily assumed by Captain A. N. Damrell, Corps of Engineers, under instructions from Chief of Engineers.

The appointment and complete instructions for the prosecution of the work were sent to Mr. Thomas Pearsall, at Montgomery, by Captain A. N. Damrell, it being considered injudicious for Mr. Pearsall to visit Mobile, on account of prevalence of yellow fever there.

Material for the work was purchased and forwarded to Mr. Pearsall to Montgomery, Alabama, and received by him on the 15th of November, and he left Montgomery for Demopolis, Alabama, on the 6th of December, to commence the survey.

On the 12th of December, Colonel J. H. Simpson, Corps of Engineers, relieved Captain A. N. Damrell of charge of operations. On the 28th of December, all preparations being completed, work was finally commenced.

Mr. Pearsall confined his operations to a mere examination of the river, from the head of navigation to its mouth, and submitted his report on the 27th of March, 1871, which report was forwarded to the Chief of Engineers with a letter from Colonel J. H. Simpson, dated 17th of April, 1871, the conclusion he arrived at being as follows: According to his report, the river from Columbus, Mississippi, the head of high-water navigation, three hundred and seventy miles above its confluence with the Mobile River, and four hundred and twenty miles above Mobile, down to Demopolis, Alabama, the head of low-water navigation, a distance of about one hundred and seventy miles, on account of its sandy banks and bed and topography of adjoining country, as well as very small supply of water, is not susceptible of permanent improvement, by the use of dams and locks. With regard to the river from Demopolis to its confluence with the Mobile River, he is of the opinion that no permanent improvement in the navigation can be made, for the same reason which obtains in the reach above Demopolis.

After the discharge of Mr. Pearsall, Mr. Henry C. Fillebrown, having been sent to examine the character and location of the bridge of the Alabama and Chattanooga Railroad Company, which spans the Tombigbee River at Jones's Bluff, forty-nine miles above Demopolis, against which the steamboat captains and pilots on the river, as well as the Board of Trade of Mobile, have protested as an obstruction to navigation of the Tombigbee River, submitted reports on this subject, and also on the possibility of improving the river, which reports indicate that the river is susceptible of improvement, principally by the removal of snags and sawyers, at a cost of $21,500, which appropriation is asked for.

These reports of Mr. Fillebrown, specifying the points at which improvements can be made, were forwarded with my letter of the 17th of April to the Chief of Engineers.

Amount allotted from appropriation of July 11, 1870, for the survey		$4,800 00
Expended under Major C. B. Reese, during third quarter 1870	$285 25	
Expended under Captain A. N. Damrell, during part of fourth quarter, 1870	114 00	
Expended by Colonel J. H. Simpson during fourth quarter 1870, and first and second quarters 1871.	2,130 17	
Transferred for the completion of survey of Apalachicola River	1,761 50	
		4,290 92
Amount available		509 08
Amount desired for improvement of the river		$21,500 00

O 5.

UNITED STATES ENGINEER OFFICE,
Mobile, Alabama, April 17, 1871.

GENERAL: I have the honor to submit, herewith inclosed, the report of an examination of the Tombigbee River, with a view to its improvement, under the act of Congress approved July 11, 1870.

* * * * * * * * *

Having occasion to send my assistant, Mr. Henry C. Fillebrown, to examine the character and location of the bridge of the Alabama and Chattanooga Railroad Company, which spans the Tombigbee at Jones's Bluff, forty-nine miles above Demopolis, against which the pilots and steamboat captains running the river, as well as the Board of Trade of Mobile, have protested as an obstruction to the navigation of the Tombigbee, Mr. Fillebrown has submitted reports on this subject, as well as on the capability of the improvement of the river, and I respectfully refer you to them for detailed account of the localities required to be improved. By these reports it will be seen that the river is susceptible of improvement at an estimated cost of $21,500, as follows:

At McGrew's Shoal, one hundred and twenty-two miles above Mobile, by widening the channel	$4,500 00
At Pevey's Landing, one hundred and twenty-seven miles above Mobile, removal of wreck	2,500 00
And dredging channel-way through bar, at that point	1,500 00
At Slater's Rock, one hundred and fifty-two miles above Mobile, removal of snags	7,500 00
At Osage Bar, one hundred and fifty-five miles above Mobile, dredging channel-way	1,000 00
At Pierson's Shoal, two hundred and thirteen miles above Mobile, or thirty miles below Demopolis, reconstructing wing-dam	1,500 00
To this I would add for removing snags from Upper Tombigbee River, at Ten-mile Shoal below Columbus, referred to by Mr. Pearsall, or, if found more expedient, for cutting new channel across neck of land at Wild-Cat Bend in that shoal	1,500 00
Contingencies	1,500 00
Total appropriation called for and which I would recommend for improving Tombigbee River, from its mouth to head of high-water navigation, or Columbus	21,500 00

In regard to the bridge of the Alabama and Chattanooga Railroad Company at Jones's Bluff, as Mr. Fillebrown's reports will show, while there can be no just complaint, either regarding its construction or the width of channel-way afforded by the draw, there are very grave objections against its present location, for the reason that boats going down stream do not see it in time to provide against the danger of its being not open; and there is no question that a location 300 yards farther down the river would not only not be objectionable, but the interests of navigation require this change.

I am, very respectfully, your obedient servant,

J. H. SIMPSON,
Colonel of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

UNITED STATES ENGINEER OFFICE,
Mobile, April 3, 1871.

GENERAL: In accordance with your instructions, I have collected all available information from pilots and steamboat captains concerning the Tombigbee River, and respectfully submit the following statement of facts obtained:

Captain William Matthews, agent of the Tombigbee line of steamers, and Captain Taylor, one of the oldest and best pilots on that river, coincide in the opinion that no general permanent plan of improvement can be applied to the river. They think that the navigation can be improved by the removal of snags from different localities, but that the effect will be but temporary. Both of these gentlemen referred me to the operations of Captain McCartney, who worked for some time removing obstructions from the Tombigbee, under a contract with the State of Alabama.

In an interview with Captain McCartney, the following information was obtained: Under a contract with the State of Alabama, he was to remove the obstructions between McGrew's Shoal (seventy miles above the mouth of the Tombigbee River) and Demopolis, for the sum of $20,000. He worked three seasons and fulfilled the terms of his contract. The heaviest work done was, according to his statement, at Turner's Shoal, where he had to remove the wreck of a large steamboat lying directly across the channel, and Wood's Bluff, where he had to excavate a channel-way 600 feet in length, 45 feet in width, and 3 feet in depth, (600 feet by 45 feet by 3 feet,) through a bed of solid rock. As these obstructions have been permanently removed, he is of the opinion that the sum of $20,000 would suffice to remove the existing obstructions, in the shape of snags, sunken logs, and bars. He also thinks that there are several points on the river where the navigation can be improved, by the construction of wing-dams. He built several of them under his contract with the State, and claims that they have been of permanent benefit. The dams constructed were of a primitive character, consisting of scows, loaded with rock, sunk in the passage-way between one side of an island or bar and the bank of the river, deflecting the whole volume of water into one channel. These scows have decayed, but the stone is still in place, producing, as he claims, the desired effect.

Captain Ham. T. Johnston, owner and commander of the steamboat National, who is regarded as one of the best-informed steamboat men here, coincides with Captain McCartney in his views regarding the improvement of the river, and its cost. He states that the rock composing the wing-dam at Pierson's Shoal (constructed by Captain McCartney) has settled to such an extent as to greatly impair its usefulness, and suggests that it be improved by being made higher. The necessary rock for the purpose can be obtained from a point only two and a half miles above, and the cost of the reconstruction would not exceed $1,500. The balance of the estimated amount, applied to the removal of snags, widening the channel at different points, and dredging a passage-way through fixed sand-bars, would, in his opinion, render the Tombigbee River navigable, at all seasons of the year, to Demopolis.

Regarding the bridge at Jones's Bluff, I am informed that all the pilots and steamboat captains united in a protest against it as an obstruction to the navigation of the Tombigbee. I have subsequently learned that the Mobile Board of Trade forwarded a similar protest to Congress in January last. The objections urged are against the location of the bridge, not its construction. Pilots complain that the bridge being located in a sharp bend of the river, just behind a point making out from the east bank, it is impossible for them to ascertain whether the draw is open (when coming down the river) until they are within a couple of boats' lengths of it. If the draw should not be open at the time they round the point, they claim that they would have to back up against a heavy current, and run the risk of being swept down against the piers of the bridge before they could get "sternway" on their boat. The general statement of the pilots is to the effect that not one of them would dare attempt to pass through the draw-way of this bridge after nightfall on their downward trip.

The foregoing information was obtained only from those who were considered the most reliable men in their profession, and I am satisfied that it is entitled to belief.

Respectfully submitted.

HENRY C. FILLEBROWN,
Civil Engineer.

Brevet Brigadier General J. H. SIMPSON, U. S. A.,
Colonel Corps of Engineers.

UNITED STATES ENGINEER OFFICE,
Mobile, April 10, 1871.

GENERAL: In obedience to your order of the 4th instant, I proceeded to Demopolis and Jones's Bluff, on the Tombigbee River, and examined the railroad bridges spanning the river at those points. Owing to the recent heavy rise in the Tombigbee River, I was unable to carry out that part of your order which referred to my "making a careful examination of the banks of the river up to those points."

I collected such information as could be obtained from the pilots and other officers of the steamboat Clara, and found that their statements regarding the character and extent of obstructions to navigation on the Tombigbee River agreed, even in detail, with the data obtained from different steamboat men which has already been furnished you.

The first important locality to which my attention was called was McGrew's Shoal, one hundred and twenty-two miles above Mobile by river. The obstructions at this point consist of rocks, through which a channel-way 40 feet in width has been excavated. This channel, in addition to its being narrow, is very tortuous in its course. The river first makes an abrupt bend to the left, and then, turning a long narrow point, makes an obtuse angle to the right, running nearly parallel to its first course. The distance across the neck of this point is but one mile, while to go around it requires a detour of five miles. Banks of the river low and flat on both sides. The rocky shoal lies just along the lower side of the long point referred to, and extends for a distance of half a mile. The channel through this shoal could be widened at a comparatively slight expense, and the pilots state that no further improvement is required to render the passage at this point safe at all seasons of the year.

At Pevey's Landing, five miles above McGrew's Shoal, there is an obstruction, consisting of a wreck, which lies immediately in the low-water channel. The banks of the river at this point are low and sandy, and there are fixed sand-bars crossing the channel-way, which impede navigation. A channel-way dredged through these bars for a distance of 600 feet, with an average width of 50 feet, and depth of two and a half feet, (600 feet by 50 feet by 2½ feet,) and the removal of the sunken wreck referred to above, will give free navigation at this point during the low stage of water.

At Slater's Reach, one hundred and fifty-three miles above Mobile, there is a perfect "nest of snags," extending for a distance of nearly a mile. The lower end of the reach is the most difficult of navigation, and the pilots informed me that during low water they were obliged to "push their boats from side to side of the channel with poles." This locality is regarded as the most difficult of navigation on the river, not only during the period of extreme low water, but also when there is four or five feet water in the channel. Captain H. R. Johnston, an old steamboat man, reports that in coming through this reach, on his downward trips, he is obliged to reverse the engines of his boat, drift down with the current, and keep a strong force of men at work to keep the boat clear of the snags that line the channel-way throughout the greater length of the reach. He considers this the worst, or, to use his expression, "the most *snaggy* point in the river."

Just above the reach we arrive at Osage Bar. This is a sand-bar, which extends across the river at low water, and impedes navigation to such an extent that boats are frequently turned back from this point, it being impossible to get over the bar. From the best information I have been able to gather concerning this locality, Osage Bar has existed as an obstruction to navigation during the last twenty-five years without any material changes having taken place in it. There is but little current here during low water, and I would suggest that if a channel-way 400 feet long, 50 feet wide, and 2½ feet deep, (400 feet by 50 feet by 2½ feet,) were dredged through this bar, it would afford a good passage-way for boats for a number of years.

If the snags were removed from the different points along the Tombigbee River, the channel-way at McGrew's Shoal widened, a channel-way dredged through the sand-bars at Pevey's Landing, and the sunken wreck removed, and the passage-way dredged through Osage Bar, I am confident that boats could ply between Mobile and Demopolis during the entire year. I would suggest the employment of a combined dredge and snag boat similar to those in use on the Missouri and Arkansas Rivers; one boat of that construction, if properly managed, could clear the river in the course of two seasons.

The bridge of the Selma and Meridian Railroad Company crosses the Tombigbee at a point four miles below Demopolis. This is a wooden structure, and is in a bad state of repair. The draw affords an opening of seventy feet on each side of the central pier, which is hardly sufficient to allow of the safe passage of the large class boats which ply between Mobile and Demopolis; the steamboat National having an extreme width of 55 feet, has but 7½ feet to spare on each side, in passing through the opening. When allowance is made for the "batter" of the piers, the width of the opening at low water is diminished to 65 feet. The piers are located parallel to the course of the current, but the present structure requires renewal. In case of its reconstruction, I would suggest the propriety of changing the location of the abutment-piers of the draw, so as to increase the width of the opening. The shore-spans of this bridge have recently been strengthened by putting supports under the middle of each, the bridge having "swagged down." River has a high bluff bank on the west side, but the approach to the bridge from the eastward is by way of a trestle-work, some fourteen feet in height; this trestle-work gave way under a passing train, some weeks since, causing a considerable loss of life; the point where the accident occurred is but a few hundred feet from the bridge.

About twenty miles below Jones's Bluff there is a rock shoal, known by steamboat men as Spring Bluff Shoal. This is a rocky bar or ledge, some 300 feet in length, extending across the river, with a depression in the ledge next the west bank, in which the low-water channel is located: this channel could be improved by blasting away some projecting points of rock and thus widen the passage-way.

I passed through the draw opening of the bridge of the Alabama and Chattanooga Railroad Company which spans the Tombigbee at Jones's Bluff, and made a careful examination of the location and construction of the bridge. There can be no complaint made either regarding its construction or the width of passage-way afforded by the draw. The piers are located very nearly parallel to the course of the current, and there is a clear opening on either side of the central pier of 91 feet. In going up stream a steamboat meets with no delay if the draw is open, and can run through either by day or night. In coming down the river the case is different.

The approach to the bridge at Jones's Bluff from above is by way of a sharp bend of the river; a narrow point makes out from the east bank just above the bridge, rendering it impossible to see whether the draw is open or not until a boat is within about 400 feet of the bridge. On the west bank of the river and within 150 feet of the west abutment of the bridge, there is an indentation, or "pocket," worn into the chalky cliff to the depth of 150 or 200 feet. The water rushing into this pocket forms eddies and counter-currents so strong as to very materially affect the course of a boat. Should the draw be closed at the time a steamboat rounds the point above, it would be impossible to stop her headway until she was within the influence of these eddies. In that case, they would be obliged to "back up" against these heavy currents, which would test the extreme power of the engines. The river at this point is very deep, and the main volume of the water passes along the foot of the bluff, but is deflected from the lower point of the "pocket" mentioned above, and passes under the draw at a slight angle with the piers. The bridge is of the "Truss" pattern, wooden superstructure, resting upon brick piers; the west abutment-pier is located just under the face of the bluff, and there are two piers in the water east of the draw-pier. The approach to the bridge from the eastward is by means of trestle-work.

I consider that this location of this bridge is, to say the least, a very unfortunate one for the steamboat interests. Were the bridge located but 300 yards farther down the river, the difficult navigation would have been entirely avoided; as it is, there is but the distance of a good boat's length to allow a vessel to "straighten up" in after passing the point above. Taking into consideration the currents which are encountered just after a boat rounds the point, this is entirely insufficient. In conclusion, I would state that, in my opinion, the bridge of the Alabama and Chattanooga Railroad Company spanning the Tombigbee River at Jones's Bluff, *is in its location an obstruction to navigation.*

From the information which I have obtained from pilots and others who are conversant with the obstructions which exist to the safe navigation of the Tombigbee, I am satisfied that the sum of $20,000, judiciously expended, as indicated in the foregoing, would suffice to remove the obstructions now existing, and give fair navigation between Mobile and Demopolis during the season of low water.

Respectfully submitted.

HENRY C. FILLEBROWN,
Civil Engineer

Brevet Brigadier General J. H. SIMPSON, U. S. A.,
Colonel Corps of Engineers, Mobile, Alabama.

O 6.

3. EXAMINATION AND SURVEY OF MOUTH OF APALACHICOLA RIVER, FLORIDA.

By act of Congress approved July 11, 1870, the Secretary of War was directed to cause an examination or survey, or both, to be made at the mouth of Apalachicola River, Florida.

By letter from the Chief of Engineers, dated July 23, 1870, Major C. B. Reese, Corps of Engineers, was intrusted with this work.

The death of Major C. B. Reese, and the prevalence of the yellow fever, delayed the commencement of the work.

Captain A. N. Damrell, Corps of Engineers, who assumed charge temporarily after the death of Major C. B. Reese, was relieved by Colonel J. H. Simpson, Corps of Engineers, on the 12th of December, 1870.

Instruments and material were purchased for the survey, and by letter of 19th of January, 1871, from Colonel J. H. Simpson, Captain A. N. Damrell was instructed to take measures for the immediate prosecution of this work, and to proceed to Apalachicola after the completion of other duties assigned to him in the same letter. By letter of Colonel J. H. Simpson, dated January 18, 1871, Mr. C. F. Trill was appointed as an assistant on this survey.

On the 19th of January, 1871, Mr. C. F. Trill received complete instructions to proceed to Apalachicola, Florida, and inaugurate the work. On the 28th of the same month work was commenced by organizing a party, locating and arranging for the erection of platforms, taking soundings, and obtaining such information as might be of use in prosecution of the work. From this time work was pushed along as rapidly as the weather would permit.

By letter from Colonel J. H. Simpson of the 20th of April, 1871, Captain A. N. Damrell was directed to turn over this work to Mr. C. F. Trill, leaving with him full instructions to insure the proper completion of the survey, and to return to Mobile, Alabama.

At this time the examination and survey had been carried across the bar at the mouth of the river to 11 feet of water on the outer slope. A preliminary examination had been made for the purpose of locating the best channel to be improved across the Buckhead and other shoals in the eastern portion of St. George's Sound, to enable vessels to reach the city by the eastern pass, between St. George's Island and Dog Island. A preliminary examination had also been made to determine the practicability and propriety of improving New Inlet, which is a channel through St. George's Island, nearly south of Apalachicola, and almost in the prolongation of the natural channel across the bar at the mouth of the river.

The survey was afterward conducted by Mr. C. F. Trill, till the 30th of June, 1871, at which time the field-work was completed as far as the funds available would allow.

By the 1st of September, 1871, it is presumed that the field and office work will be completed, and a complete report, accompanied by maps and estimates, will be forwarded as soon thereafter as practicable.

Amount allotted from appropriation of July 11, 1870......	$2,400 00
Expended up to June 30, 1871, surplus being from funds transferred from Tombigbee River survey..............	3,116 59

APPENDIX P 1.

NEW YORK, *May* 13, 1871.

GENERAL: I have the honor to transmit herewith the final report of my assistant, Captain William Ludlow, Corps of Engineers, and explanatory chart of the survey and examination of Charleston Harbor, provided for in section 2 of the act of Congress approved July 11, 1870.

The two charts prepared by Captain Ludlow have been placed upon a single sheet in preparing the one now submitted, and some data, at points not covered by the recent examination, have been added from former surveys, in order to render, as far as practicable, a reference to other charts and sources of information unnecessary.

The following recommendations, covering the expenditure of the money now available "for the improvement of the ship-channel in Charleston Harbor," and estimates for continuing the work, are respectfully submitted.

Project for expending the $13,000 now available:

1. For the removal of the boiler of the iron-clad gun-boat Palmetto State, sunk in the mouth of Town Creek to 12 feet, low-water soundings	$1,000 to $1,200
2. For the removal of the boilers of the two gun-boats Chicora and Charleston, sunk off Marshall's wharf, Charleston	2,000 to 2,400
3. For removing turret of monitor Patapsco, sunk near Fort Sumter to 15 feet, low-water soundings.	1,000 to 1,200
4. For the removal of the two wrecks, the Beatrice and companion, sunk in Beach Channel	7,500 to 8,500
Total	11,500 to 13,300

5. Should the money more than suffice for the accomplishment of the work above named, the balance to be applied to dredging Beach Channel, using for this purpose the steamer and pump to be chartered for work on St. John's Bar, in case my project of the 9th instant, for operating on that bar, is sanctioned; otherwise balance to be applied, if sufficient—

5 *a*. In removing wreck at Fort Sumter............ $1,000 to $1,200

I propose to invite proposals at once for executing the foregoing project.

ESTIMATES.

For continuing and, so far as our information now indicates, for completing the improvement of the ship-channels in Charleston Harbor, the appropriation of the several amounts below named is recommended, viz:

1. For removal of wreck near Fort Sumter	$1,200 00
2. For removal of wreck of monitor Weehawken, sunk in main channel abreast of Morris Island	12,000 00
3. For removal of wreck of wooden gun-boat Housatonic, sunk outside the bar, in the track of northern-bound vessels	10,000 00
4. For dredging Beach Channel to a depth of 15 feet, and a width of 275 feet, low-water soundings	10,000 00
5. For removing 125 lineal feet from the end of Bowman Jettee, to a depth of 20 feet, low-water soundings	8,000 00
For removing hull of monitor Patapsco	20,000 00
Total to be appropriated	61,200 00

Should the proposed removal of 125 feet from the end of Bowman Jettee be executed with such results as to suggest a further reduction in the length of that work, an additional appropriation will be requested.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Major of Engineers, Brevet Major General.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

P. S.—As the removal of the turret of the monitor Patapsco secures 15 feet of water over the wreck, I have included it in the project for expending the existing appropriation, and have placed the cost of removing the hull the last on the list of estimates, for which appropriations are recommended. Should it be deemed necessary to reduce the estimates, this item ($20,000) may be omitted, making the total amount to be appropriated $41,200.

Q. A. GILLMORE,
Major Engineers, Brevet Major General.

NEW YORK, *October* 20, 1870.

CAPTAIN: * * * * * * *

In addition to these current observations, you are charged with "the examination or survey of Charleston Harbor, South Carolina," provided for in section 2 of the act of Congress making appropriations for rivers and harbors for the fiscal year ending June 30, 1870, for which the sum of $3,000 has been allotted. This must cover all expenses for field-work, office-work, and instruments.

I suggest that you assume personal charge of this survey, confiding the current observations to your assistants. The "examination or survey" should take note of and cover all important changes in the water-channels used for commerce, that have occurred since the last survey made by the Coast Survey in 1866.

Particular care should be taken in reporting upon the location and character of obstructions in the channels, such as wrecks, in order that intelligent recommendations may be made concerning the propriety and cost of their removal.

Very respectfully, your obedient servant,

Q. A. GILLMORE,
Major Engineers, Brevet Major General.

Captain WILLIAM LUDLOW,
Corps of Engineers, U. S. A., New York City.

ENGINEER OFFICE,
Charleston, South Carolina, April 20, 1871.

MAJOR: I have the honer to submit the following report on the survey and examination of Charleston Harbor, made in accordance with your instructions of October 20, 1870.

The large chart shows the field-work done, on a scale of 1,250 feet to the inch, or $\frac{1}{15000}$; and the tracing gives a scale of 500 feet to the inch, or, $\frac{1}{6000}$, the hydrography of the Beach Channel.

Inasmuch as the survey had for its object to ascertain by what means the harbor and its channels of entry might be improved, no time was lost in verifying the minor details of the Coast Survey chart; the instrumental work being at once directed to the point suggesting the possibility of improvement, the various wrecks in the harbor claiming consideration most readily, and a study of the harbor, and the records of previous examinations directing attention immediately to the Beach Channel. The position of the wrecks have been carefully determined, as well as those of the buoys and beacons; in the majority of instances correcting these as given on the Coast Survey chart, while, for the detail of the shore-lines, the chart has been followed.

It was thought a matter of interest, in connection with a consideration of the régime of the harbor, to ascertain if any effect had been produced upon the curves of depth by Forts Ripley and Sumter, and soundings were accordingly made upon the middle ground surrounding Fort Ripley, and along the edge of the James Island Bank, from Fort Johnson to Sumter, thence in the direction of Cumming's Point.

No change of consequence is apparent on the middle ground; in fact, there is a remarkable resemblance between the two outlines of the shoal. On the James Island bank, however, it is evident that Fort Sumter has exerted a positive though not as yet a very important influence on the outline of the bank. It appears that above Sumter the 3-fathom curve has been pushed back toward James Island, while east of the fort the curve has encroached considerably upon the deep water. In connection must be considered the fact, which the chart does not show, that in the vicinity of Sumter, and above it, the bank itself has been upheaved to a very considerable extent. The rationale, then, would seem to be that the fort, acting as a solid bulk-head, resists the incessant denudating action of the ebb-tide, and checks its flow over the shoal, and thus allows the bank to rise in height from increments deposited by the flood, at the *same time* the ebb is compelled to follow more the channel-line, and so act with increased pressure against the shore of James Island Bank, cutting it away somewhat, while, from being deflected over toward Sullivan's Island, (with a powerful influence on the beach channel) it allows the 3-fathom curve beyond the fort to gradually increase its distance to the east, until the two curves again meet off Cumming's Point. In this effect is not seen anything that can act unfavorably upon the channel-way, but merely a circumstance worth noting from its influence on the Beach Channel.

The soundings made upon the bar of the Pumpkin Hill Channel are undoubtedly in excess of the actual average depth. This is owing to the fact that for nearly a month preceding the time when the soundings were taken the wind, blowing from easterly directions, had maintained more than average depth of water upon the bar. I have given the soundings as they appear in the field-book, since they do not bear upon any recommendation made in this report; but to show the average mean low-water depth, about 18 inches should be deducted from each sounding.

The detailed report of the wrecks is given as follows, commencing with those furthest up the harbor.

1st. *The Palmetto State.*—This was an iron-clad gun-boat of southern construction, sunk in the mouth of Town Creek, just above the city, in 1865; it has been blasted by wreckers, working under a contract with the Treasury Department, and the machinery taken out. There are 12 feet of water over the decks, but only 6 feet over the boilers. Though not an important obstruction, it has caused disaster, and should be removed by blasting out the boiler to a depth of 12 feet at low water. To effect this would cost about $1,000.

2d. *The Chicora and the Charleston.*—These two wrecks have the same history as the Palmetto State, and lie nearly together in the Cooper river, below Drum Island, off Marshall's wharf. They have both been operated upon by wreckers, but the boilers remain as obstructions to vessels coming into the wharf. Over the wrecks themselves is as much water as near them, but the boilers are but 2½ feet below the surface at low water, and they should be removed. The cost is estimated at about $1,000 apiece, $2,000.

3d. *The wrecks near the entrance to Hog Island Channel* are unimportant.—They probably aid in maintaining the reef or shoal which connects them with Shute's Folly Island, and may have a favorable influence in deflecting some of the flow from the Cooper River toward the city, which would otherwise escape by the Hog Island Channel.

4th. *The wreck on James Island Bank* consists of a boiler and other iron, but is entirely out of the channel, and does not require attention.

5th. *The wreck near Fort Sumter* consists of a boiler, &c.; and although no obstruction to commerce, should be removed for the reason that it deflects the tide from the head of the wharf at Sumter, thereby gradually shoaling the water. It will be cheaper to remove the wreck now than to extend the wharf hereafter. Probable cost, $1,000.

6th. *The Patapsco* was a single-turreted monitor, sunk in the channel-way near Fort Sumter. It has been heavily blasted. The decks over the engine-room blown off, although the engines are still in her. The pilot-house has been removed. The turret is inclined at an angle of about 35° to the west. There is now 15 feet of water over the wreck, except on the turret, the upper corner of which is but 5½ feet below the surface. The great force of the current here renders the wreck the most difficult of all to work upon. To remove it entirely would be the proper method of dealing with it, and from the best opinion I can form, the cost to obtain 20 feet of water would be about $20,000. To blast off the turret, so as to have 15 feet over the wreck, would cost, say $1,000.

7th. *The Weehawken* was a single-turreted monitor, sunk off Morris Island, in a nearly east and west position, directly across the channel. It has been heavily blasted, and there are now 11½ feet of water over everything. The engines have been taken out. The turret, of 12-inch iron, was blasted to pieces with an interior charge of 475 pounds of powder. The pilot-house, of 10-inch iron, was burst with two charges, one, underneath, of 475 pounds, the other, inside, of 250 pounds. The pieces of both lie in the hold of the vessel with the boilers. The sand has banked up on both sides of the wreck, except at the stern, which lies to the west, where the bottom has cut out for a distance of 40 feet, and the stern has broken off and fallen, holding to the remainder of the wreck by the lower parts. The wreck should be, as nearly as possible, removed. The estimated cost is $12,000.

8th. *The Keokuk* was a double-turreted monitor, and lies in 15 feet of water, near the south end of Morris Island. It has 11 feet of water over it, and 1 foot on the turret. It lies entirely out of the path of any vessel, except a stray coaster bound south from Charleston; and even they can only in smooth water approach it, owing to its proximity to nearly constant breakers. From the same cause the wreckers have not disturbed it. To remove the wreck to a depth of 15 feet would cost $20,000.

9th. *The Housatonic* was a wooden vessel, blown up at anchor by a torpedo-boat, which sunk with her. The wrecks of the two lie nearly four miles due east of the Weehawken light-ship, in 4½ fathoms of water. It is given in the margin of the chart.

The wreck has been blasted, the stern blown off, and portions of the machinery taken out. Two boilers are still in her, weighing 40 and 50 tons each. From the quarter forward the ribs stand up to their full height, giving about 7 feet at low water. The wooden sheathing inside, and the planking outside, are eaten by worms down to the copper. It is a dangerous wreck, lying in deep water, in the track of northerly-bound vessels, and should be removed. The estimated cost to obtain 20 feet of water, is $10,000.

All these amounts are, as nearly as possible, estimated for the actual cost of removal, and if contracts are made, the contractor is supposed to look for his profit to the value of the material raised.

10th. *The wreck of the Raccoon* lies upon the north breaker of the north channel, and is no obstruction.

11th. *The wrecks in the Beach Channel* remain to be considered. These have been referred to in my preliminary report of January 27, 1871. They consist of the Beatrice and her companion, on Drunken Dick Shoal, and the Minho, Stono, and Prince Albert, on and near the end of Bowman Jettee. The position of these wrecks protects them from heavy seas in all directions, and they are almost constantly in comparatively smooth water; and in the event of a storm, the wrecking-boat can easily seek protection by passing round the jettee into the harbor. The water near them is not very deep, nor is the flow of the tide through the Beach Channel as rapid as in other points of the harbor. I am, therefore, inclined to believe that the amounts originally estimated for them would suffice for their removal; but this point has been already covered by your recommendation of an appropriation. The conclusions arrived at, as to the direction to be given to efforts to improve the harbor, do not vary from those suggested in my preliminary report. The channels now generally used, viz, the Pumpkin Hill, for all large vessels, and the Swash, for smaller ones bound north, are, in all probability, absolutely incapable of permanent improvement except at some vast expense. Their exposed position, the shifting, uncertain nature of the fine sand composing their bars, the prevalence of northeast, southeast, and southwest winds, whose fury is fully exercised upon them, the consequent changes, sometimes sudden, in depth and direction, all seem to discourage attempts to discover an effective plan of improvement. Dredging with some form of rotary pump of great power, and with improved appliances, might, by constant work, maintain upon these bars an increased depth of water. Notwithstanding that the expense of this would be great, and its efficiency uncertain, it might be advisable to make the attempt, were it only to ascertain what relation the cost would bear to the value of increased commerce and immunity from disaster, and at least have a basis of calculation and comparison. But, fortunately, there is found in the Beach Channel a direct opportunity of making a permanent improvement, and, by a comparitively small expenditure, give at once a channel of entry which shall be safe, convenient, and commodious. The permanent nature of this channel is proved by the various surveys made from time to time, which always give it in the same position, while the other channels have shifted continually. It has, at the present time, a depth of water greater than the Pumpkin Hill Channel, is sheltered in all directions from heavy seas until a safe depth is reached, is easy of access from the ocean, cuts off some 15 miles in distance for vessels in the northerly coasting trade, and would undoubtedly be used by all vessels bound north, were it not for the wrecks that obstruct it, and possibly some apprehension of the lumps at the inner mouth and the close approach of the Drunken Dick Shoal to the Bowman Jettee. The yellow curve in the small tracing shows those portions in the channel where the depth is 15 feet or more. It will be seen that a clear 15 feet can be carried through, except at two points near the inner mouth, where the curves approach to about 100 yards. Dredging on these two bars, and removing the 11-foot lump at the end of the jettee to a depth of 15 feet, would open the channel straight through. To effect both these objects, it is estimated, would cost about $10,000, putting the cost of dredging at $1 per cubic yard.

There is one other recommendation made in my preliminary report for the improvement of the Beach Channel, to which it is again necessary to refer, viz, the removal of a portion of the Bowman Jettee. I am constrained to believe that this is required to render the Beach Channel all that its proper régime would make it, for reasons that may be given, as follows:

At the time the jettee was built, the sea had encroached upon the shores of Sullivan's Island, had attacked and partially undermined the walls of Fort Moultrie, and threatened, by making a breach across the island, through the low place east of the fort, to imperil its existence. The jettee was built, and at once its favorable action was evinced. The high-water mark rapidly receded from Fort Moultrie; the whole line of the beach advanced against the ocean, and the smaller jettees and sea-wall supported the Bowman Jettee, repulsed the attack of the sea, and allayed the apprehensions felt for the safety of the island. Another effect, this time an unexpected one, was discovered. The jettee had been built to connect the Drunken Dick Shoal with the shore, and so close what, (at that time, from the incessant washing of the sea into it,) *was not* a channel, but a slue-way of uncertain depth and no importance. But when the abrading action of the sea and tides upon the shore was checked suddenly, the channel opened and deepened, and began to attract attention as an available entry to the harbor. There was, however, a limit to this reaction, and at a time when the jettee still extended to a distance of 560 feet beyond low-water mark, a normal and comparatively constant condition of things was established. The shore no longer encroached upon the deep water, except upon the east side of the jettee, where it was protected from the tremendous rush of the ebb-tide out of the deep reservoir within, and formed an angle having the jettee at its apex. It was evident that the jettee had reached the limit of its usefulness in building out and maintaining the shore. The curves in the tracing show this remarkably, where the 1-fathom curve on the east side is 100 feet beyond the 2-fathom curve on the west side; the 2-fathom curve on the east reaching nearly to the end of the jettee, while opposite to it are 4 and 5 fathoms. Removing 250 feet of the jettee would bring it back to the 1-fathom curve on the east side, and give an opportunity for the escape of perhaps double the amount of water through the channel, and probably do away with the necessity of dredging altogether. I do not think any apprehension need be felt of the Drunken Dick Shoal approaching the jettee, as it is removed, believing that the increased pressure against it would at least retain it in its present position, and knowing that the end of the jettee rests upon a steep shelf of marl rock, which would itself act as a break and furnish no material for filling up the channel. My idea would be to begin at the extreme end of the jettee, and remove a section at a time of, say, 50 feet, then allowing a little time for the development of the effect produced, take off another section, and so on, stopping as soon as the most favorable condition was reached. The whole to be done under careful supervision, and the material raised to be piled upon the jettee, inside of the 250 feet. That the effect would be favorable, I do not doubt; that it is needed, I am also convinced. At present there is some danger in entering and emerging from the channel, as the powerful tide that sweeps past its mouth, both on the ebb and flood, would turn a large vessel almost half-way round before it had time to clear the jettee or the shoal, and so make it dangerous to go in or out, except near slack-water. This would restrict the usefulness of the channel, even were it deep and open, and render shipmasters timid about using it.

In support of these conclusions to which I have come, I would quote from a report made by Professor Bache, Coast Survey, Lieutenant Kurtz, United States Engineers, and Lieutenants Maffit, Maury, and Davis, United States Navy:

"The deposit of sand on both sides of the jettee (Bowman's) has greatly modified the shore-lines, to which it has added, at a mean, more than 100 yards. The tendency of the obstruction which this work presents to the ebb is undoubtedly to deflect the water more through the north channel, and it is one of the considerations going to show the stability of the Sullivan Island channel, that it has not been more affected by the action of the jettee."

Lieutenant Maury, in another report, says: "The ebb-tide in this locality runs with great force, * * * * * and over the jettee it is very rapid until half-ebb, when the exposure of the rocks by the falling of the water produces an eddy-current favorable to the deposit which the flood-tide has already made."

Captain Bowman, in his report to the Chief of Engineers, of October 11, 1839, says: "The proposed work (the construction of the jettee) * * * * will cause the extension of Sullivan's Island to the south. * * * It will concentrate the water upon the bar of the north channel, and increase its depth."

Captain Cullum, in his report of November 10, 1857, to the commissioners of the State of South Carolina, for the improvement of Charleston Harbor, in conjunction with whom he was working, says: * * * "Connected with the improvement," (that of dredging the channel,) "I deem it important to remove to the depth of 16 feet, at low water, the extreme outer end of Bowman's Jettee, which projects into the proposed channel."

After arriving at a more thorough knowledge of the depth of water around the jettee, I find that my former rough estimate of the cost of removal of 250 feet of it was entirely too small. I derived my idea of the depth from the soundings on the east side. For a depth of 20 feet, and length of 250, I estimated the cost at $15,750, and for the same depth and length of 125 feet, it would be about $8,000.

SUMMARY OF ESTIMATES.

1st. For removing wrecks—	
Palmetto State	$1,000 00
Chicora and Charleston, each $1,000	2,000 00
Wreck at Fort Sumter	1,000 00
Patapsco, (to 20 feet)	20,000 00
(To remove the turret only)	[1,000 00]
Weehawken, (20 feet)	12,000 00
Keokuk, (15 feet)	20,000 00
Housatonic, (20 feet)	10,000 00

2d. For dredging Beach Channel	$10,000 00
3d. For removing 250 feet Bowman's Jettee	15,750 00
(For removing 125 feet Bowman's Jettee)	[9,000 00]
Total	100,750 00
Or, omitting the amounts in brackets	91,750 00

I send, herewith, a communication from Mr. Geo. W. Clark, transmitting their statements of the marine business of the port of Charleston, South Carolina.

I have endeavored to obtain from the Chamber of Commerce, and they from other persons intimately acquainted with the business of the port, an estimate of the increased value of commerce which would follow a permanent improvement in the channel of entry. But I find that these estimates vary within large limits, and are practically of no value. The percentage of increase is variously put at 25, 50, and 100 per cent. I should say the first figure would be nearest the truth. A large amount of cotton is shipped to New York for exportation which would, with an increased depth of water on the bar, be sent directly from this port, thus increasing its business and prosperity. The export of the phosphates, which is rapidly becoming an important item, would be greatly increased. It is a heavy cargo, and requires deep draught for large vessels.

I am indebted to my assistants, Messrs. Eppley and Guerrero, for their faithful and intelligent co-operation in the field-work.

Very respectfully, your obedient servant,

WM. LUDLOW,
Captain of Engineers, Brt. Lt. Col. U. S.

Major Q. A. GILLMORE,
Corps of Engineers, U. S. A., New York City.

CUSTOM-HOUSE, CHARLESTON, SOUTH CAROLINA,
March 23, 1

SIR: Acknowledging receipt of your communication of 20th instant, informing [illegible] such information pertaining to the business of this port desired by yourself, [illegible] hand, I have the pleasure to transmit for your uses tabular statements as follows:

	No.	To
A.—Of vessels entered at this port during the year 1870 from foreign ports	124	39,
B.—Of vessels cleared at this port during the year 1870 for foreign ports	160	63,0
C.—Of vessels entered coastwise at this port during the year 1870	540	370,6
D.—Of vessels cleared coastwise at this port during the year 1870	461	335,3

E.—Imports at this port during 1870	$547,6
F.—Exports at this port during 1870	11,184,3
G.—Duties received during 1868, 1869, and 1870	706,5

In this connection, I beg to state that many vessels enter and clear at th without reporting at this office, they being under license, and laden with do goods only. How large the number of such is, can only be conjectured. My op would place the number at, say 300 to 400, at least.

Should any other statistics be desired, please advise.

Respectfully, &c.,

GEORGE W. CLARK,
Collect

WILLIAM LUDLOW,
Captain Engineers, Brevet Lieutenant, Colonel U. S. A., Charleston, S. C.

NOTE.—The tabular statements are omitted as unnecessary, the information contain being summarized in the letter of the collector above.

Q. A. GILLMORE,
Major of Engineers, Brevet Major Ge

APPENDIX Q.

UNITED STATES ENGINEER OFFICE,
Baltimore, Maryland, September 11, 1871.

GENERAL: I have the honor to transmit herewith papers as follows:

In one package the annual report for each of the following works:

Improvement of Patapsco River below Baltimore.
Improvement of Susquehanna River, near Havre de Grace.
Improvement of Potomac River below Georgetown.
Improvement of Rappahannock River below Fredericksburgh.
Improvement of James River below Richmond.
Improvement of Appomattox River below Petersburgh.
Improvement of Roanoke River below Weldon.
Improvement of Cape Fear River below Wilmington.
Improvement of the harbor of Queenstown, Maryland.
Improvement of the harbor of Cambridge, Maryland.
Examinations, surveys, &c., on Atlantic, as follows:

Wicomico River, near Salisbury, Maryland; James River and Kanawha Canal, enlargement and extension; Accotink, Neabsco, Quantico, Aquia, Choppawamasic, on Potomac River; Norfolk Harbor, Elizabeth and Nansemond Rivers; Roanoke River; Neuse River; Cape Fear and Deep Rivers, as high as La Grange.

In a second package, recapitulations of each of the foregoing.

In one or two cases the usual commercial statistics are not found. This is either because I was unable to procure them, after application to the proper officials, or else they are to be shortly forwarded with special reports.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

Q 1.

Annual report for fiscal year ending June 30, 1871, *of the improvement of the entrance to the harbor of Baltimore, in Patapsco River, and Chesapeake Bay.*

On the 1st of July, 1870, operations had been some time suspended for want of funds. By the act approved July 11, 1870, an appropriation of $42,900 was made. The dredges and scows which belonged to the United States were taken in hand, and repaired sufficiently to carry them through the remainder of the working-season, already well-advanced. Dredging began about the 1st of September and was continued during that month and the next, in the lower or new channel. During November the dredges were worked in the Brewerton Channel. On the 6th of November the charge of the improvement was transferred to me by Colonel J. H. Simpson, who was ordered to another post of duty. The dredging was discontinued about the close of November, and the machines brought to anchor for the winter near town, in a secure place. The dredges and scows were shortly afterward sold, under the authority of the Honorable Secretary of War. They were old, and for a long time had annually needed heavy repairs, making them an expensive property for the United States. Other reasons were set forth in my report of November 12, 1870, in which the sale was

recommended. These need not be repeated here. The prop
sold, after due advertisement, for fair prices. The proceeds a
ble for continuing the improvement. An appropriation of $5
made by the act approved March 3, 1871.

After due advertisement, a contract for dredging was mad
date of April 20, 1871, with Mr. M. F. Brainard, of Albany
begin in June. The dredging has been confined to the Brewert
nel, in which Captain J. H. Cooper, the efficient port warden,
ously co-operated with two of the dredges under his cha
Brainard, although apparently putting forth his best effort
the fulfillment of his contract, has not made as good progre
anticipated. His machinery is good, but, being new, has work
and has proved weak at some points. A constant improve
lately been observed in his work, and a still greater change
better during the remainder of the season is confidently

Proposals will be invited and new contracts made for a
dredging in both channels, covering the whole of the funds
for the work.

The Brewerton Channel needs greater width, as does also
channel below. The Brewerton Channel is provided with n
cons, which greatly facilitate its use, but these very importan
aries for the efficient use of the lower channel have not yet
nished. It is hoped their erection will not be much longer delay
interesting letter to Colonel Simpson, from Port Warden Coop
pertinent to the matter under consideration, is here inserted a
mended to special attention.

PILOT OF
83 *Thames Street, Baltimore, November*

GENERAL: It affords me pleasure to say that at your invitation, on the 19
a delegation from the Baltimore (Maryland) Pilots' Association, (includin
examined the Craighill Channel.

We sounded it thoroughly from both sides of the steamer, going down a
ous points coming up, and found 21 feet of water at average low tide. Th
can be used by steamers drawing 19 or 20 feet, as long as the buoys remai
present position; but for sailing vessels of heavy draught its width, 200 feet,
row to use without assistance of steam-tugs, as the buoys cannot be relie
being apprehended that the running of ice will remove or displace them, a
are no landmarks that can be used in running this channel, it will requir
lights to be erected before its general use can be availed of. But with mor
channel, and the erection of lights, it will not only be found perfectly saf
miles will be saved in the sailing distance between Baltimore and Cape He

With much respect, general, I remain your obedient servant,

JOHN H. COOP
President Baltimore (Maryland) Pilot A

Brevet Brigadier General J. H. SIMPSON,
Colonel of Engineers, Baltimore, Maryland.

Until lately, the depth of water aimed to be attained, and de
be sufficient, has been 22 feet at low water. The vast increa
commercial importance of Baltimore since the late civil war,
great development of her trade, especially by steam with foreig
has made the desire for a greater depth than 22 feet at low wa
strong, and the urgency for it very great. Being called upon
mates of the cost of obtaining a greater depth, communicati
made, of the following tenor, to the Board of Trade, the Corn a
Exchange, and the harbor committee of the city council:

UNITED STATES ENGINEER OFF
Baltimore, Maryland, April

MY DEAR SIR: In your letter, March 27, is found the following:
"They will be pleased to have, at your earliest convenience,
the cost of dredging the Brewerton and Craighill Channels, both,

23, and 25 feet respectively, at medium low tide; and for width of 200, 300, and 500 feet in the Brewerton, and for 300 and 500 feet width in the Craighill Channel. Please recommend what you consider the most advisable width we should endeavor to obtain in either or both channels."

As stated in a previous communication of March 28, 1871, the survey of the Patapsco was delayed by heavy rains and high winds. I regret you did not mention the cause of this delay, to which you refer in your late letter to the city council. I am able, however, now, to give the information you desire.

CRAIGHILL CHANNEL.

Width, 300 feet; depth, 21 feet	$21,600 00
Width, 300 feet; depth, 23 feet	54,000 00
Width, 300 feet; depth, 25 feet	212,000 00
Width, 500 feet; depth, 21 feet	56,000 00
Width, 500 feet; depth, 23 feet	156,000 00
Width, 500 feet; depth, 25 feet	300,000 00

BREWERTON CHANNEL.

Width, 200 feet; depth, 21 feet	$106,400 00
Width, 200 feet; depth, 23 feet	244,000 00
Width, 200 feet; depth, 25 feet	440,000 00
Width, 300 feet; depth 21 feet	208,800 00
Width, 300 feet; depth, 23 feet	492,000 00
Width, 300 feet; depth, 25 feet	736,000 00
Width, 500 feet; depth, 21 feet	430,000 00
Width, 500 feet; depth, 23 feet	892,000 00
Width, 500 feet; depth, 25 feet	1,461,000 00

FROM END OF BREWERTON CHANNEL TO FORT M'HENRY.

Width, 200 feet; depth, 21 feet	$10,500 00
Width, 200 feet; depth, 23 feet	55,500 00
Width, 200 feet; depth, 25 feet	130,000 00
Width, 300 feet; depth, 21 feet	15,900 00
Width, 300 feet; depth, 23 feet	83,100 00
Width, 300 feet; depth, 25 feet	196,200 00
Width, 500 feet; depth, 21 feet	27,000 00
Width, 500 feet; depth, 23 feet	138,600 00
Width, 500 feet; depth, 25 feet	327,000 00

To give a channel 24 feet deep at mean low water, of width as follows:

Craighill Channel, 400 feet; Brewerton Channel, 250 feet; from end of Brewerton to Fort McHenry, 250 feet, will cost $757,000. To give a channel of the same width as just stated, but of a depth of 23 feet, will cost $542,000.

I regard these *widths* as the smallest with which a great city like Baltimore should be satisfied. As to the depths, I have nothing to say, except that to obtain the depth of even 25 feet, though costly, would be probably the most remunerative in the end to the city.

Any further information will be furnished with pleasure.

Very respectfully,

WM. P. CRAIGHILL,
Major of Engineers.

Mr. JOHN S. WILLIAMS,
Chairman of Committee Corn and Flour Exchange, Baltimore, Maryland.

An appropriation of $200,000 is recommended for the fiscal year ending June 30, 1873.

Hon. John L. Thomas, jr., under date of July 28, 1871, writes as follows:

In compliance therewith, I have to state that the sum collected, in coin, for the fiscal year ending June 30, 1871, as duties on imported merchandise, was $8,892,528 98, and the total receipts for the same period, including currency derived from tonnage, hospital, storage, steamboat inspections, licenses to pilots and engineers, &c., amounted to $8,993,036 70.

* * * * * * * *

The arrival and entry of vessels from foreign ports, for the last two and a half years, bear the following proportions: 1869, 650 vessels; 1870, 735 vessels; from January, 1871, to June 30, 1871, 508 vessels.

The increase within the last six months is in greater proportion than that of the preceding years, and, according to the ratio of increase for the six months of the present year, will exceed that of last year more than one-third in number.

The amount of merchandise, the quantity of which is determined by weight, is also annexed for your consideration, and is as follows:

Amount of merchandise weighed during the fiscal year ending June 30, 1870—

	Pounds.
Imports	317, 259, 977
Exports	3, 718, 112
Transportation in bond	5, 437, 094
Total	326, 415, 183

Amount of merchandise weighed during the year ending June 30, 1871—

	Pounds.
Imports	394, 875, 496
Exports	5, 157, 833
Transportation in bond	13, 563, 290
Abatement	11, 294, 771
Total	424, 891, 390
Excess over the year ending June 30, 1870	98, 477, 152

This is exclusive of merchandise measured, gauged, in packages, &c.

The domestic exports for 1870 and the six months ending June 30, 1871, are as follows:

1870	$12, 460, 687
1871, (six months ending June 30, 1871)	8, 842, 123
Total	21, 302, 810

The foreign imports for the same period as follows:

1870	$21, 017, 313
1871, (six months ending June 30, 1871)	15, 049, 921
Total	36, 067, 234

The whole of his interesting letter is appended hereto; an abstract of bids received is also appended.

Amount expended during fiscal year ending June 30, 1871	$20, 453 30
Amount to be expended in fiscal year ending June 30, 1872	92, 010 58
Amount required for fiscal year ending June 30, 1873	200, 000 00

Abstract of proposals for dredging in Patapsco River below Fort Carroll, opened at 12.10, *p. m., April* 1, 1871.

Name and residence of bidder.	Time of commencement of work.	Time of completion of work.	Amount in yards per day.	Kind of machine.	Price per yard for removal and deposit.
Emory R. Seward, Albany, N. Y.	Apr. 15, 1871	Aug. 15, 1871	1, 000	Osgood	34 cents.
J. Taggart, Melrose, Mass. (Not duplicate.)	At once				33⅓ cents; no guarantors.
Chas. J. De Graw, Fulton, N. Y.	May 1, 1871	Oct. 15, 1871	800 to 1, 000	Osgood	38⅛ cents.
Alanson Dodge, Fulton, N. Y.	May 3, 1871	Jan. 1, 1872	2, 500	Osgood & Otis.	46 cents.
Gilbert & Ferris, Brooklyn, N. Y.	May 1, 1871	Oct. 1, 1871	500 to 1, 000 each	2 or more of Osgood's.	53 cents.
James Caler, Brooklyn, N. Y. (Not duplicate.)	June 15, 1871	With dispatch.			98 cents.
Morris F. Brainard, Albany, N. Y.	June 15, 1871	Oct. 15, 1871	1, 000	Carmichel & Osgood.	28 cents.
Morris & Cummings, New York City.	May 25, 1871	Sept. 25, 1871	600 to 800	Morris & Cummings.	48 cents; rock not included.

CUSTOM-HOUSE, BALTIMORE,
Collector's Office, July 28, 1871.

SIR: I have the honor to acknowledge the receipt of your letter of the 25th instant, requesting me to furnish you with information respecting the amount of revenue collected at this port during the fiscal year ending June 30, 1871, and any other information kindred thereto that may have a bearing upon the further improvement of the entrance to the harbor of Baltimore.

In compliance therewith, I have to state that the sum collected in coin for the fiscal year ending June 30, 1871, as duties on imported merchandise, was $8,892,528 98, and the total receipts for the same period, including currency derived from tonnage, hospital, storage, steamboat inspections, licenses to pilots and engineers, &c., amounted to $8,993,086 70.

In order to obtain an appreciable idea of the extent of the foreign commerce of this port for the time mentioned, it will be proper, in this connection, to state that for six months of that time the duties were collected under the new tariff rates, which are about one-third less of what they were the six months previous; so that it may be fairly estimated that the duties, at the old rates, would have exceeded the sum of $10,000,000, which are in excess of the previous year, and greatly above the total receipts of any previous year at this port.

For the purpose of furnishing you with a general idea of the increase of foreign trade at this port, I append a list of receipts of duties in coin, exclusive of currency for each calendar year named below:

1860	$1,166,590 77	1866	$4,665,064 35
1861	722,443 04	1867	5,798,820 85
1862	1,946,242 43	1868	6,217,496 41
1863	1,919,229 99	1869	9,027,513 45
1864	2,167,120 05	1870	9,113,718 58
1865	2,983,208 33		

It will be observed that the increase for 1870 was not proportionate to that of the preceding years, which fact may be accounted for, because of two reasons: 1st, Franco-Prussian war, which suspended for a time the Bremen line of steamers; and 2d, the merchants, in expectation of reduced rates of duty, imported cautiously, and also warehoused largely their goods, which were not withdrawn until the year 1871. The fact must also be taken into consideration that quantities of merchandise, shipped to this port, are again exported, as well as transported, to a considerable extent, to inland ports west, where the duties thereon are paid, and consequently the amounts so collected do not enter into the receipts here.

The arrival and entry of vessels from foreign ports, for the last two and a half years, bear the following proportions:

1869	650 vessels.
1870	735 vessels.
From January, 1871, to June 30, 1871, six months	508 vessels.

The increase within the last six months is in greater proportion than that of the preceding years, and, according to the ratio of increase for the last six months of the present year, will exceed that of last year more than one-third in number.

The amount of merchandise, the quantity of which is determined by weight, is also annexed for your consideration, and is as follows:

Amount of merchandise weighed during the fiscal year ending June 30, 1870:

	Pounds.
Imports	317,259,977
Exports	3,718,112
Transportation in bond	5,437,094
Total	326,415,183

Amount of merchandise weighed during the year ending June 30, 1871:

	Pounds.
Imports	394,875,496
Exports	5,157,833
Transportation in bond	13,563,290
Abatement	11,294,771
Total	424,891,390

	Pounds.
Excess over the year ending June 30, 1870	98,477,152

This is exclusive of merchandise measured, gauged in packages, &c.

The domestic exports for 1870, and the six months ending June 30, 1871, are as follows:

1870	$12,460,687
1871, (six months ending June 30, 1871)	8,842,123
Total	21,302,810

The foreign imports, for the same period, as follows:

1870	$21,017,313
1871, (six months ending June 30, 1871)	15,049,921
	36,067,234

In connection with the above, I will add that it often occurs at this port that vessels entering with foreign cargoes have to be lightened at Swan Point and other intermediate places, varying from seventeen to thirty miles from Baltimore, before they can reach their landing. This difficulty occurred in several instances, last winter, with the line of steamships engaged by the Baltimore and Ohio Railroad Company, running between here and Liverpool. Doubtless you are thoroughly familiar with the facts, but I deem it proper to mention them, because, coming as they do under my official notice, I am made cognizant of the drawbacks inflicted upon the commerce of Baltimore, and the embarrassments to which it is subjected thereby, and, as a consequence, preventing an increase of revenue to the Government.

If any further information in reference to the commerce of Baltimore is desired by you, previous to the submission of your report to Congress, I will cheerfully supply it.

I am, very respectfully,

JOHN L. THOMAS, *Collector.*

Major W. P. CRAIGHILL, U. S. A.,
United States Engineer Office, Baltimore, Maryland.

Q. 2.

Annual report upon the Susquehanna River below Havre de Grace, Maryland, for the fiscal year ending June 30, 1871.

An appropriation of $12,000 was made by the act of July 11, 1870. Under a contract with the American Dredging Company, of Philadelphia, operations were begun September 20, 1870, in dredging a channel 100 feet wide and 10 feet deep at low water, extending from near Fishing Battery light to mouth of the dredged channel. The contract price was 25 cents per cubic yard.

I relieved Colonel Simpson of the charge of the work on the 7th of November, 1870. The channel having been completed to a width of 75 feet, and the season becoming very inclement, operations under this contract were suspended December 19, 1870.

In accordance with my recommendation of February 8, 1871, I was authorized to use the material of the old, movable deflector, and such moneys as might be available for this purpose, for the construction of a fixed wooden dike or deflector, to concentrate the flow of the river, as had been proposed, and partially accomplished by the temporary movable structure built in the fall of 1867. The projected dike was to consist of piles driven 5 feet apart, braced by sloping piles behind them, and bolted to them; the whole connected by strong, double-cap pieces, between which 3-inch planks were to be closely driven, forming a nearly water-tight barrier.

The separation, selection, and preparation of old material were commenced in March, 1871, and the driving of piles about the middle of April. The line selected requires 3,500 linear feet of structure, and on the 30th of June all the vertical piles were driven, (700,) 1,200 linear feet of double capping were in place, 350 back-piles driven and secured, and 100 linear feet of sheet-piling were driven. It is hoped to complete the work during August, 1871.

As this work, consisting of wood entirely, cannot be expected to endure very long, and as I am still of the opinion (as expressed in previous reports to the Chief of Engineers) that a concentration of the flow of the river at this point is the most feasible and economical method of improvement, I recommend the appropriation of $50,000 for the completion of this work in a more permanent manner; that amount can be profitably expended during the next fiscal year.

The improvement is in the collection district of Baltimore, which is the nearest port of entry; it extends from opposite Point Concord Light to Spesutie Island.

The trade between Baltimore, Philadelphia, and New York, and the Susquehanna Valley to near its head, is interested in this work. The amount cannot be certainly ascertained.

Amount of revenue collected at Baltimore as duties on imported merchandise for the fiscal year was, in coin, $8,892,528 98.

The following proposals have been received for excavating channel: F. B. Colton, American Dredging Company, 25 cents per cubic yard; N. G. Dodge & Co., 29½ cents per cubic yard; Edgar M. Payn, 30 cents per cubic yard; E. R. Seward, 40 cents per cubic yard.

The following is the only contract made for this work:

For excavating channel, with American Dredging Company, price as proposal above, (see first part of this report.)

Expended in fiscal year ending June 30, 1871	$11,253 35
Available for fiscal year ending June 30, 1872	7,283 05
Required for fiscal year ending June 30, 1873	50,000 00

Q 3.

Annual report on the improvement of the Potomac River for the fiscal year ending June 30, 1871.

This improvement was in charge of Major N. Michler, Corps of Engineers, from the 1st of July, 1870, until the early part of November, 1870, when, under orders from the War Department, I relieved him of the duties and responsibilities connected with it.

An appropriation of $50,000 was made by the act approved July 11, 1870, for the improvement of the river between the Long Bridge and Georgetown, D. C.

After due advertisement, a contract, dated October 20, was made for the excavation of a channel within the limits prescribed by the law, which, however, did not receive the approval of the Chief of Engineers.

On the 29th of November, 1870, the following letter was addressed to the Chief of Engineers:

UNITED STATES ENGINEER OFFICE,
Baltimore, Maryland, November 29, 1870.

GENERAL: In response to the call of November 23d, for information as to the propriety of increasing the depth of water in the Potomac, between the Long Bridge and Georgetown, beyond 12 feet or to 15 feet, as suggested in my letter of November 19th, I have the honor to report as follows:

The appropriation of $50,000 for the Potomac, made by Congress at the last session, was to be expended between the Long Bridge and Georgetown, and was obtained, as be to use it in *making*, not improving a channel. To make a chan anywhere else between the Long Bridge and Georgetown, would whole appropriation. I determined, therefore, to recommend the appropriation in increasing the depth of the Georgetown channel water, and to a width of about 200 feet. This will require the 100,000 cubic yards of material. The contract price for removal and under certain circumstances, and 51 cents under others.

The proposed improvement of the Georgetown channel would nearly the whole of the appropriation. A small margin should be contingent expenses. I considered whether it would be best to gi feet in width and 15 feet in depth, or 12 feet in depth and greater question for decision by the business people interested in the in prefer the narrow and deeper channel.

On Saturday afternoon last, November 26th, I had an interview w the port of Georgetown. He did me the honor to address to me a com date of the 28th of November, a copy of which is inclosed. I inc two other letters of November 28th, one from Mr. Evan Lyons, Merchants' Exchange of Georgetown; the other from Mr. Alexande chief business men of that city. Their opinions are entitled to car and much weight. It is my own opinion that the commerce o languished for want of greater depth of water than 12 feet, and it i portance to justify an increase of depth to 15 feet, or even more if mo

The fact that vessels can arrive and leave with only partial collector assures me is of frequent occurrence, is a proof that arran made, if practicable, to permit such vessels to arrive and depart w they have done in times past, and would do again if they could, the of the place making their use highly advantageous, if they could com and preferable to the use of smaller vessels, with which the business content itself to a great degree.

It is proper I should here remark that the opinion I have expresse manner of spending the existing appropriation of $50,000 would not agreeing to, or even strongly recommending, a different treatment between the Long Bridge and Georgetown, provided it was a part of improving the river between Alexandria and Georgetown.

The erection of the Long Bridge was a great injury to the navigatio River, and it is idle to attempt a permanent improvement of the riv structure remains.

A dredged channel seldom remains permanent, unless steps are tak cause of the deposition.

The deposition in the Potomac is due very much to the obstru caused by the Long Bridge. This deposition will continue as long a

I have a contract just awaiting signature in which the depth is the only part remaining to be fixed. I expected work under it to be begun December 1.

If the recommendation I have made above is approved, I should be pleased to be notified by telegraph, in advance of the written communication.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL, *Major of Engineers.*

Brigadier General A. A. HUMPHREYS, U. S. A.,
Commanding Corps of Engineers, Washington, D. C.

The recommendations of that letter having been approved, a contract was at once signed, and the work of excavation has been carried forward as rapidly as circumstances allowed. The work has been delayed by ice in winter, by freshets in the spring, and by sickness among the workmen.

A map of the river, from Georgetown to Giesboro Point, was made during the past winter, from surveys made from time to time, mainly under the supervision of my predecessor.

At the request of some of the prominent men of business of Georgetown, an examination of the river opposite that place was made in June, 1871, for the purpose of determining precisely the location and extent of certain rocks or other obstructions, with a view to having their positions carefully marked by buoys or otherwise, and with the hope of their ultimate removal.

The result of this examination was communicated to the Chief of Engineers, with the following remarks:

GENERAL: I have the honor to acknowledge receipt of your instructions of June 27, relative to the Potomac River, in which further information is called for before a decision is made as to the application to the removal of certain rocks near Georgetown of a portion of the balance of an existing appropriation for the river, instead of applying it all to dredging, as previously contemplated.

A copy of a letter from Captain C. B. Phillips is inclosed, which indicates the present condition of the channel.

It will be observed that a channel 100 feet deep in width, and 15 feet in depth at low water, has been excavated, but that for several obvious causes the depth of 15 feet is not maintained throughout. Two of these causes only will be mentioned, either of which is sufficient to account satisfactorily for the fact of shoaling. One is the occurrence of freshets, unusual in number if not in violence. The other cause referred to is the slimy semi-fluid condition of much of the material on the bottom of the Potomac River in this part of its bed.

I take the liberty of inserting here one or two short extracts from my report of November 29, 1870:

"A dredged channel seldom remains permanent unless steps are taken to remove the cause of the deposition.

"The deposition in the Potomac is due very much to the obstruction to its flow caused by the Long Bridge, especially in time of freshets.

"To give a useful depth of 12 feet, requires the excavation to be 13 or 13½ feet deep. An excavation of 15 feet gives not more than a useful depth of 13½ or 14 feet, and this is only for a short time."

In the report of November 29, 1870, it was recommended that a channel be dug 200 feet wide and 15 feet deep at low water. This recommendation was approved, and the work has since been carried on as rapidly as circumstances permitted, with the results stated in Captain Phillips's letter.

The contractor, who is a man of energy, has been delayed by several causes. The river was for weeks closed by ice soon after the signature of the contract in December, 1870. Since the disappearance of the ice, there has been an unusual frequency of freshets. The requirement for the deposition of the dredged material behind Analoston Island, in a place where it could not get back into the channel, has also caused some delay. These delays have been annoying to all concerned, but to none more than myself, and I have more than once seriously considered the propriety of endeavoring to make other arrangements for the dredging, in the hope of expediting the work; but it seemed better to bear present ills than to make changes which might bring others and greater.

Captain Phillips estimates that, to carry out the designs of excavating a channel 200 feet wide and 15 feet deep, would require the further removal of 57,000 yards, which, at 33 cents, would cost $18,810. This could be done, as the available balance for the river is $21,000.

On the other hand, to reduce the width of cutting to 175 feet, would reduce the quantity of excavation to 43,000 yards—

At a cost of	$14,190 00
The estimated cost of removing rocks near Georgetown	6,050 00
	20,240 00

It seems, therefore, practicable to give a channel 175 feet wide, and to remove the rocks near Georgetown.

The recommendotion of my letter of June 26, 1871, is renewed, that authority be given me to remove, by contract, the rocks, thereby diminishing the amount of dredging in the channel.

Very respectfully, your obedient servant,

WILLIAM P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

It was, however, decided to expend the appropriation in dredging according to the approved project, and not to undertake the removal of the rocks until more money should be available for the improvement of the river. The dredging will be completed during the autumn of 1871.

The immediate supervision of this work was, in December, 1870, committed to Captain C. B. Phillips, Corps of Engineers, who has my thanks for the satisfactory manner in which he has performed that duty, as well as others of importance I have had occasion to intrust to him.

The regimen of the Potomac River, in the space embraced within the original limits of the District of Columbia, has been greatly modified within the last century. This change is due to several causes. One of these is the conversion of a large extent of country bordering the stream from a forest into a cultivated section. Another is the growth of large cities and towns upon its banks. Still another is the building of bridges for crossing the river, as well as the pushing out of wharves and other structures from its banks into the stream. Several of these artificial works have not been arranged as well as they might, with a due regard to the preservation of the channels of the river for the purposes of commerce. The result of all these causes has been the formation of extensive deposits, covering large areas between Georgetown and Alexandria. The channels formerly existing have either been obliterated or greatly changed in position and depth.

The great extent of the causeway of the Long Bridge is, beyond serious question, of constant detriment to the river. In the drift of events, however, it appears to have become a thing not to be gotten rid of or materially ameliorated. In any scheme of improvement for the river, the continued presence of that structure must, it would seem, be taken into the account.

The interests centered in Georgetown press constantly in the direction of the retention and improvement of the Virginia channel, to the disregard of the Washington channel. They have in their favor the strong argument that nature, in her adjustment of the regimen of the river to existing circumstances, keeps open, as the only continuous navigable channel, what is known as the Virginia or Georgetown channel.

On the other hand, it is suggested by others that an unobjectionable course of procedure would be to close up the Virginia channel entirely above the Long Bridge, and open the Washington channel in the same part of the river. That by so doing access to Georgetown would not be impaired, while the water front of Washington would be greatly improved.

To spend more money on the Virginia channel would seem a waste, if it is ultimately to be closed by a breakwater or a dam, as has been proposed by some. To close it seems running in the face of the indications of nature. It seems very desirable that an authoritative decision should be speedily obtained, and some policy fixed as to the improvement of this river, in which the General Government is so much interested.

No further expenditure seems necessary at this time for the Virginia channel. Under the action of causes already referred to, it will gradually fill up to a considerable extent, and then must be dredged out again, with the same process of filling to occur.

It would seem proper to turn attention now to the improvement of the Washington channel, below Long Bridge, for which an appropriation of $50,000 is recommended. The opening of the cut proposed from Maryland draw of Long Bridge to Easby's Point will cost not less than $100,000.

For the removal of rocks near Georgetown, $10,000 is needed.

Expended in fiscal year ending June 30, 1871	$26,568 54
Available for fiscal year ending June 30, 1872	23,431 46
Asked for fiscal year ending June 30, 1873	160,000 00

Respectfully submitted.

WM. P. CRAIGHILL,
Major of Engineers.

Proposals for deepening the channel and for removing obstructions in the Potomac River.

Number.	Name of bidder.	PLACE OF DEPOSIT. On flats adjacent to Washington, per cubic yard.	PLACE OF DEPOSIT. Into deep water, within 2,000 yards of place of dredging, per cubic yard.	Excavation of rock, per cubic yard.
1	Evans & Teemyer	$0 95	$0 45	$12 00
2	Alfred Lee	95	45	5 00
3	William D. Wise	90	45	4 50
4	J. W. Howard	70	35	4 00
5	E. H. French	67	....	2 50
6	F. Eckloff	60	30	3 00
7	N. G. Dodge	51	33	3 00
8	H. Murray	45	35	*3 50 †3 75
9	H. Birch	40	30	*2 50 †3 00

* In deep water. †On flats.

Q 4.

Annual report for the fiscal year ending June 30, 1871, on the improvement of the Rappahannock River, Virginia.

A report on the improvement of the Rappahannock River was made two most important shoals, at Fredericksburgh and Spot and to the removal of one of the wrecks most interferi posed new channel. In order to insure the result tha propriated should give an available channel throughout the cut was reduced in its dimensions to 90 feet width at low water.

Proposals were invited for the execution of this work of March, 1871. An abstract of the bids received is ap

The bid of Mr. G. H. Ferris, Brooklyn, New York, f was accepted, and operations were commenced by him Bar. All the bids received for the removal of the wreck too high, and consequently rejected. Subsequently, concluded with Mr. R. D. Minor, of Richmond, (abstra commence operations July 15, 1871.

A contract was also made with Messrs Hebrew & Asse Virginia, for the removal of wrecks on the lower portio be completed within the fiscal year ending June 30, 18

It is expected, during this season, to complete a cha through Fredericksburgh and Spottswood Bars, giving a nel of that depth, from mouth of river to head of navig move all the most important wrecks from the river be

It will require about $75,000 to complete the whole w intended, and that amount could be profitably expende

The tendency of the river-bed to assume its condition improvement by dredging, will, of course, still exist, thou it will be so materially lessened and retarded in its a posed works, that an annual expenditure of $5,000 will s improvement in good condition.

The trade and commerce to be benefited by this impro the coastwise and foreign trade in grain, tobacco, and co manufactured goods. The river drains a large and f country, and a slack-water navigation and canal mak outlet for one of the richest farming regions of Vi

Abstract of bids for work on Rappahannock River, Virginia, as per advertisement of March 28, 1871; opened at 12.10 p. m., April 28, 1871.

No. of bids.	Names of bidders.	Address.	Time of beginning.	Time of completion.	Kind and No. of machines.	Price per yard.
1	G. H. Ferris	Brooklyn, N. Y	June 10	Oct. 31	Osgood's.	*$0 24½
2	Edgar M. Payn	Albany, N. Y	May 15, 1871	May 30, 1872		*27½
2a	By the same					†65
3	L. B. Rose and R. W. N. Noland	Fredericksburgh, Va	May 20, 1871	Dec. 20, 1871		‡28
4	W. R. Mason and Jno. P. Knight	Fredericksburgh, Va	May 21	Sept. 21		35
5	N. G. Dodge & Brothers	Georgetown, D. C	June 1	Dec. 1, 1871	Osgood's.	26
6	J. H. Teemyer & Co	§Washington, D. C	June 10	Sept. 1, 1871		‖40
7	E. R. Seward	Albany, N. Y	May 15	Sept. 15	Osgood's.	30

* Measured in scows. † Measured in tubs; deposited on land. ‡ Dump within 500 yards.
§ 341 Pennsylvania avenue. ‖ If deposited in five feet water, not over three miles haul.

Abstract of bids for removing obstructions from Rappahannock River, Virginia, as per advertisement dated April 17, 1871; opened at 12.10 p. m., May 17, 1871.

No.	Name and residence.	Price.	Commence.	Complete.	Remarks.
1	Hebrew & Asserson, Norfolk, Va.	*$7,750	July 1, 1871	Oct. 1, 1871	To remove as per specification.
2	A. A. Hudson, Fredericksburgh.	500	June 10, 1871	July 10, 1871	One wreck near wharf at Fredericksburg.
3	R. D. Minor, Richmond	448	June 5, 1871	June 20, 1871	One wreck at Fredericksburgh Bar, to remove by blasting.
4	Washington Jennings, Fredericksburgh, Va.	440	May 20, 1871	July 20, 1871	One wreck at wharf at Fredericksburgh.

* And wrecks.

Q 5.

Annual report upon the improvement of the James River, Virginia, for the fiscal year ending June 30, 1871.

A report on the improvement of the James River was made October 31, 1870, which was printed in Ex. Doc. No. 60, (H. R.) Forty-first Congress, third session.

An appropriation of $50,000 was made for this river by the act approved July 11, 1870. A further appropriation was made of $50,000 by the act approved March 3, 1871. The work done, and proposed to be done, with that money is the following:

Mr. B. Maillefert has removed the sunken vessels, &c., near Drury's Bluff, so as to give a clear channel-way not less than 250 feet in width and 18 feet in depth at low water. He has also removed at Warwick the wrecks of three schooners; at Graveyard Reach the wrecks of the Gallego and Plume; below Aiken's some forty piles, the remains of an old bridge.

Under another contract with the United States Engineer Department, dated June 10, 1871, Mr. Maillefert has entered upon other removals, as follows:

At Drury's Bluff, the remainder of the steamer Jamestown, steamer Virginia, the steamer Fredericksburgh, the steamer Beaufort, the schooner Wythe, the brig Marcus, and parts of several remaining stone cribs;

at Wilton, some forty or fifty piles, remains of an old bridge, and part of a steamer.

Under another contract with the United States Engineer Department, the American Dredging Company, of Philadelphia, will soon complete their work of opening the cut-off at Dutch Gap, giving a depth of 18 feet at high water, and a width of not less than 100 feet.

Under another contract with the United States Engineer Department, Messrs. Kalmback & Barton are about to open a channel through the rock at Rockett's Reef, giving a depth of 18 feet at high water, and a width of 125 feet.

The operations of the authorities of the city of Richmond have been confined chiefly to the dredging of the worst shoals. Much will still remain to be done for the improvement of the James River, as follows, viz: The removal of additional rock in boulders and beds near the city; the excavation of sand and other matter from the natural bars of the river, and its deposit in suitable places; the construction of deflecting dikes and the facing of spoil-banks, probably the excavation of cut-offs, through Jones's Neck and near Bermuda Hundred.

Abstracts of bids received for work on the James are appended.

The facts given below relative to the commerce, &c., on the James River are derived from communications from the collector of the district at Richmond:

The customs district of Richmond extends from Bermuda Hundred up James River, including the whole back country to Lynchburgh, and the tributaries of the York River.

By act of March 3, 1801, City Point was created a common port for entry of vessels for both Richmond and Petersburgh. City Point is sixty miles below Richmond by water, and two miles below Bermuda Hundred, the Appomattox entering the James between the two places. The port of Petersburgh extends from Petersburgh to City Point, on the James River. The district of Norfolk includes all of James River below City Point, although, under special authority from the Department, I have had to lighten vessels to enable them to get over Hog Island Bar, below Jamestown, up to City Point.

To your second inquiry, I would reply that I collected as duties on imports for the fiscal year ending June 30, 1871	$50,995 39
And tonnage duty	1,184 70
Making a total of	52,180 09

To your third inquiry, I would reply that the ports of entry on James River are Richmond, City Point, and Petersburgh and Norfolk, Virginia.

Expended in fiscal year ending June 30, 1871	$32,168 62
To be expended in fiscal year ending June 30, 1872, (all now under contract)	67,831 38
Appropriation required for year ending June 30, 1873	100,000 00

Abstract of bids for removing obstructions in James River, Virginia; opened September 12, 1870.

No.	Names of bidders.	Substance of bid.	Compensation.	Time of execution.	Manner of execution.	Remarks.
1	H. V. Tompkins, Norfolk, Va.	To remove obstructions as mentioned in advertisement, and to give required depth of water.	$39,500 and proceeds of wreck.	From October 15, 1870, to August 1, 1872.	Blasting and lifting...	No guarantors.
2	No signature	To remove all obstructions as given in advertisement, all by blasting, except the Fredericksburgh, Raleigh, and Wythe, which are to be raised. Piles to be drawn—				
		At Warwick Bar	5,600 and wrecks.	From November 1, 1870, to November 1, 1873.	Blasting, chiefly; raising three vessels; drawing piles.	Guarantors: Albert Ordway, John Kelly. Guarantee refers to the bid of that of George Dick, of Richmond.
		At Drury's Bluff	90,980 and wrecks.			
		At Graveyard Reach	7,500 and wrecks.			
		At Varnia	500 and wrecks.			
			104,580			
3	Geo. Dick, Richmond, Va.	At Warwick Bar, to remove obstructions, as mentioned in advertisement.	5,600	From March 1, 1870, to May 1, 1872.	Blasting	Guarantors: Albert Ordway, John Kelly.
		At Drury's Bluff, to give a channel on south side of river, 225 feet wide at bottom and 18 feet deep at low water.	25,000			
		At Graveyard Reach, to remove obstructions mentioned in advertisement.	7,500			
		At Varnia, to remove piles	500			
			38,600			
4	John A. Hebrew, Norfolk, Va.	To remove obstructions mentioned in advertisement	45,000 and proceeds of wrecks.	From November 1, 1870, to November 1, 1872.	Blasting, chiefly; to have privilege of using other means, if desirable.	Guarantors: J. B. Whitehead, H. B. Nichols.
5	Neptune Submarine Company, New York.	At Drury's Bluff, to give a channel clear of wrecks and piers, 300 feet wide and 18 feet deep at mean low water.	29,750 and proceeds of wrecks.	From October 1, 1870, to May 1, 1871, seven months.	Raising whole, hoisting with derricks, or by blasting.	Guarantors: R. C. White, L. A. Dowley. Bid not in duplicate.
		To remove other obstructions mentioned in advertisement.	6,500 and proceeds of wrecks.			
			36,250			
6	Morris & Cummings, N. Y.	To remove all the obstructions specified in the advertisement.	39,500	From September 20, 1870, to January 20, 1871, four months.	Blasting and hoisting.	Guarantors: Henry M. Bailey, Wade B. Worrall.
7	B. Maillefert	To remove obstructions as mentioned in advertisement—		From September 25, 1870, to February 25, 1871, five months.	Blasting and lifting...	Guarantors: James McCulloch, Anson S. Palmer.
		At Warwick Bar	3,350			
		At Drury's Bluff	30,150			
		At Graveyard Reach	1,500			
		At Aiken's	600			
			35,600			
8	A. D. Bishop, New York.	To remove obstructions as per advertisement	400,000. Proceeds to be property of Government.	From October 1, 1870, to October 1, 1871.	Hoisting bodily. No blasting.	Guarantors: Lowell Mason, 3d; S. C. Buffalor.

Abstract of bids for removing obstructions in James River, Virginia; opened October 31, 1870.

No.	Bidder.	Substance of bid.	Compensation.	Time of execution.	Manner of execution.	Remarks.
1	Abra'm Rothwell, Baltimore, Md.	At Drury's Bluff, to give a channel 250 feet wide by 18 feet deep at low water.	$18,000	From December 1, 1870, to June 1, 1871.	Not stated............	No bid for Aiken's. No guarantors.
		At Graveyard Reach, to remove gullies and plume.....	2,500			
		At Warwick Bar, to remove three schooners............	2,000			
			22,500			
2	O. J. Jennings & Co., Syracuse, N. Y.	At Drury's Bluff, to remove or give 18 feet at low water, over obstructions.	26,000 and materials.	From December 1, 1870, to June 30, 1871.	Blasting, dredging, or otherwise.	Bid to be understood for whole or none.
		At Graveyard Reach, remove or give 18 feet at low water, over obstructions.	4,000 and materials.			
		At Warwick, remove or give 18 feet at low water, over obstructions.	5,000 and materials.			
		At Aiken's, remove or give 18 feet at low water, over obstructions.	1,400 and materials.			
			36,400			
4	NeptuneCompany, N. Y.	To give channel at Drury's Bluff, 250 feet by 18 feet at low water, and remove other obstructions mentioned in advertisement.	29,975 and materials.	From November 20, 1870, to July 1, 1871.	Not stated............	
6	H. V. Tompkins, Norfolk, Va.	At Drury's Bluff, Graveyard, Warwick, and Aiken's, to remove obstructions.	38,750 and materials.	From December 1, 1870, to Sept. 1, 1872.	Not stated............	No guarantor.
		Or to remove, as before, at all but Drury's, and then give a channel 250 feet by 18 feet at low water.	35,750 and materials.			
9	H. D. Norris, New York City.	At Drury's Bluff, to give channel 250 feet by 18 feet....	27,000 and materials.	From December 1, 1870, to July 1, 1871.	By blasting, as far as practicable.	
		At Graveyard, to remove obstructions.................	2,500 and materials.			
		At Warwick, to remove obstructions..................	3,750 and materials.			
		At Aiken's, to remove obstructions..................	500 and materials.			
			33,700			
11	John A. Hebrew, Norfolk, Va.	At Drury's, to remove obstructions....................	29,000 and materials.	From April 1, 1871, to October 1, 1872.	Blasting, when raising whole is impracticable.	Bid to be understood for whole or none.
		At Graveyard, to remove obstructions.................	2,500 and materials.			
		At Warwick, to remove obstructions..................	2,000 and materials.			
		At Aiken's, to remove obstructions..................	500 and materials.			
			34,000			
12	Geo. Dick, Richmond, Va.	To give at Drury's a channel 250 feet by 18 feet, and to remove obstructions at Warwick and Graveyard.	24,000 and materials.	From December 1, 1870, to July 1, 1871.	Blasting and lifting...	No bid for Aiken's.

14	B. Maillefert, New York.	To remove all obstructions at Drury's, Graveyard, Warwick, and Aiken's.	$26,300 and materials.	In 5 months, to begin November 15, 1870.	Blasting and lifting...	
		Or to remove as above, except at Drury's, and there to give a channel of 250 feet by 18 feet, at low water.	$14,400 and material removed in that operation.	In 3 months, to begin November 15, 1870.	Blasting and lifting...	
15	A. D. Bishop, New York.	To remove obstructions, per advertisement............	$400,000. Does not want material, but will sell it for the Government.	From March 15, 1870, to March 15, 1872.	Lifting with derrick..	

Abstract of bids for opening Dutch Gap Canal in James River, Virginia ; opened October 31, 1870.

No.	Names of bidders.	Substance of bid.	Compensation.	Time of execution.	Manner of execution.	Remarks.
3	O. J. Jennings, Syracuse, N. Y.	To re-open Dutch Gap Canal, as per advertisement......	47 cts. per cubic yard, measured in dump boats.	From December 15, 1870, to June 30, 1871.	Dredging or otherwise.	
5	John W. Parks....	To re-open Dutch Gap Canal, as per advertisement......	50 cts. per cubic yard.	From November 10, 1870, to June 30, 1871.	Not stated...........	
7	American Dredging Company, Philadelphia, Pa.	Excavation, removal, and deposit by dumping scows	33 cts. per cubic yard, in embankment and cut.	March 1, 1871, to June 1, 1871.	Excavate	
8	Elijah Brainard, Albany, N. Y.	Dredge out and deposit earth, as per advertisement.....	38¼ cts. per cubic yard, measured in scows.	December 20, 1870, July 1, 1871.	Dredging	
10	James Caler, Stanford, Conn.	To do necessary excavation and deposit material where required.	43 cts. per cubic yard.	Not stated	Dredging	No guarantors. Bid not in duplicate.
13	B. Maillefert, New York City.	To remove earth or other material	72 cts. per cubic yard, measured in cut.	November 15, 1870, April 15, 1871.	Not stated	

Abstract of bids received April 29, 1871, for removing rock at the Rocketts, in James River, Virginia.

No.	Name.	Nature of bid.	Compensation.	Time.
1	Geo. W. Townsend, 22 State st., Boston..	Drilling and blasting; to furnish all machinery, apparatus, and material for conducting operations, except powder and other explosives, and cartridges; to work by the day, under supervision of the engineer in charge; engineer empowered to close work under the contract on 10 days' notice.	$70 for every working day.	June 1, to completion or notice to stop work.
2	.......do..................................	Drilling and blasting; to make channel of required dimensions..............	$14 per ton rock, weighed on board of vessel.	June 1, 1871, to July 1, 1872.
3	Alanson Dodge, Fulton, N. Y............	Steam chisel; to make a channel 125 feet wide, 15½ feet deep at low water—4,500 cubic yards.	$45, 000............	One year from June 10, 1871.
		To make a channel 150 feet wide, 15½ feet deep at low water—about 5,400 cubic yards.	$58, 000............	One year from June 10, 1871.
		To make a channel 180 feet wide, 15½ feet deep at low water—about 6, 500 cubic yards.	$67, 000............	One year from June 10, 1871.
		To excavate rock, and deposit where directed; rock to be measured in scows.	$11 per cubic yard.	One year from June 10, 1871.
		To time dredging-machine, scows, and crew to operate, per day of 10 hours...	$100 per day.......	
		To time good tug and crew..	$25 per day........	
		To time Osgood's steam chisel, and crew to operate..........................	$100 der day.......	
4	C. L. Kalmbach and S. M. Barton........	To form a channel as required; to be paid for each cubic yard excavated and removed.	$10 per cubic yard up to 45,000 y'ds; $7 per yard beyond 45,000 yards.	June 1, 1871, to December 1, 1871.
5	B. Maillefert, Richmond, Va.............	To form a channel as required; to excavate, remove, and deposit as directed; rock to be measured in scows or by weight.	$34 75 per cubic yard.	May 25, 1871, to May 25, 1872.

Abstract of proposals for removing obstructions from rivers, as per advertisement, dated April 17, 1871; *bids opened* 12.10 *p. m., May* 17, 1871.

No.	Name.	Residence.	Price.	Commence.	Complete.
....	....	....	....	....	....
			James River, Virginia.		
5	* Hebrew & Asserton.	Norfolk ..	$15,651 and proceeds of wrecks..	July 1, 1871	July 1, 1872
6	† B. Maillefert........	Richmond.	Proceeds of wrecks............	June 15, 1871	Dec. 15, 1871

* To remove, as per printed specifications, provided contract is awarded for all.
† To remove obstructions, as per specification, at Wilton, Drury's Bluff, and Chaffin's Bluff.

O 5.

BALTIMORE, MARYLAND, *October* 31, 1870.

GENERAL: An interesting and valuable report concerning the James River was made November 26, 1852, by a commission composed of Colonel Mansfield, of the Corps of Engineers, Professor Bache, Superintendent of the Coast Survey, and Major I. I. Stevens, of the Corps of Engineers. Their report is printed in Ex. Doc. No. 1, Senate, Thirty-third Congress, First Session, Part II, 1853, beginning at page 389.

The natural obstructions to navigation are much the same now as at the time of the report of the commission; and the map of the James River, for which the survey was begun shortly after, is a good map of the river to-day, except that it does not show, as it could not be expected to do, the artificial obstructions to navigation, which were placed in the river during the late war. These consist of sunken vessels, cribs filled with stone, and remains of the supports of military bridges. Their location is shown on the sketch transmitted to the Engineer Bureau with my letter of August 29, 1870. There is now also a cut-off at Dutch Gap, which did not exist until opened, first by the troops under General Butler during the war, and recently re-opened by the great freshet of this autumn.

Very little money has ever been appropriated by the General Government for the James River. What has been available from that source has been chiefly expended in dredging, generally in co-operation with the authorities of the city of Richmond, who have from time to time spent considerable sums in the purchase of dredges and other machinery and in operating it. Numerous large and small boulders have been removed by them from the upper part of the river near the city, and a portion of the rocky ledge at Rocketts has been excavated. This removal of rock is, of course, a great and permanent improvement of the river.

A very important defect in the dredging operations in the past has been the deposition of the material removed from the river in places where it could eventually find its way back into the channel again. The selection of proper places of deposit for the material removed from the river is quite as important as its original removal. At some points in the river deflectors are required, to concentrate the water in proper directions, and at these places the material removed by the dredges will be used in forming artificial banks with suitable timber revetments, to be ultimately replaced by stone. At other points, where it would be otherwise necessary to remove the dredged material through great distances, receptacles should be provided for it near at hand. This can be done at natural concavities in the banks at convenient points, by extending timber-work along the chords of the concaves and placing the material behind. The direction of the banks will thus be improved, while the great point will be gained of preventing the return into the channel of what has been already removed from it, perhaps more than once.

A variety of operations will be required for the permanent improvement of the James River below Richmond, viz: the removal of rock in boulders and in beds near the city; the excavation of sand and more compact matter from the natural bars of the river, and its deposit in suitable places; the removal by blasting, dragging, lifting, and dredging, of artificial obstructions placed in the channel during the late war; the construction of deflecting-dikes and the facings of spoil-banks; the excavation of the cut-off at Dutch Gap, and probably the excavation of cut-offs through Jones's Neck and near Bermuda Hundred.

While premising that any scheme of river improvement should be tentative and progressive, rather than dogmatic and absolute, I will now proceed to state generally what I propose for the James River, referring for details to the maps and other drawings accompanying this report.

The artificial obstructions should be first removed. The Dutch Gap cut-off should be made as soon as practicable, advantage being taken of what the river did there for itself during the late freshet. This cut-off will shorten the river by several miles, and entirely avoid the bad bar in Trent's Reach, of which the permanent improvement, if practicable, will be quite expensive. While the cut-off is making at Dutch Gap, a short deflector should be built just above the upper end of it.

The rock excavation near the city should have early attention in the progress of the improvement. The chief expenditure will be for dredging. The location and kind of dikes are shown on the maps and drawings.

It is proposed to give first a channel 180 feet in width by 15 feet in depth at high water. Such a channel, supposing the Dutch Gap Cut to be opened and made the avenue for navigation, will cost $120,000, including dredging, dikes, and rock excavation. A channel of the same width and depth, supposing the old route by Trent's Reach to be used, and the Dutch Gap Cut-off not made, will cost $125,000.

A channel 180 feet in width and 18 feet in depth at high water will cost, by the route of the Dutch Gap, $250,000. A similar channel by the route of Trent's Reach will cost $270,000.

The accompanying estimate in detail will show the cost of the improvement of each locality of the river where it is needed.

The idea of cutting through Jones's Neck and near Bermuda Hundred deserves careful consideration. Should Congress make further appropriations for the James River, I would recommend that authority be given for an examination into the cost of those cuts. At present, I have not considered it my duty to go to the expense of obtaining the data upon which to base such estimates.

The long straight reach, extending from Rocketts nearly to Drury's Bluff, will almost certainly require work upon it annually to maintain a channel of greater depth than nature gives. This may be the case at some other points. An annual appropriation of $15,000 should be made for the river for this object.

At the expiration of (say) ten years, when the timber-work above low water will have decayed, some of the banks will require a permanent revetment of stone, which will cost $50,000.

It is recommended that an appropriation of $100,000 be made for this river for the year ending June 30, 1872.

After notice of thirty days, several proposals were received on the 12th of September for removing the sunken ships, &c., from the river, of which an abstract was sent to the Engineer Bureau September 13. It was finally decided to reject them all, and call for new proposals for removing the obstructions, and at the same time proposals were invited for opening the Dutch Gap Canal. Several bids for each of these objects have been received to-day. It is expected that advantageous contracts will very soon be signed, and a balance left of the appropriation of $50,000 made at the last session of Congress, which will be applied, before the close of the present fiscal year, to excavation of rock near Richmond, or to other useful work in the river.

Several maps and drawings are sent by express, as follows, viz:

	Scale.
1 sheet, JamesRiver, from Richmond to City Point	$\frac{1}{40000}$
1 sheet, James River, from Mayo's Bridge to Drury Island	$\frac{1}{5000}$
1 sheet, James River, from Rockdale Creek to Curl's Neck	$\frac{1}{5000}$
1 sheet, James River, from Curl's Neck to City Point	$\frac{1}{5000}$
1 sheet, James River, showing Harrison's Bar	$\frac{1}{10000}$
1 sheet, James River, showing Hog Island Bar	$\frac{1}{20000}$
1 sheet, showing proposed cut-off at Dutch Gap, in plan, 1 inch to 40 feet.	
1 sheet, sections proposed cut-off at Dutch Gap, 1 inch to 20 feet.	
1 sheet, details of proposed dikes, &c., ⅜ inch to 1 foot.	

The plan and sections of the Dutch Gap Cut shows its condition before the freshet. The mass closing one of its mouths was removed by the action of the water during the freshet, and the cut was excavated to an average depth of about 7 feet at low water. It is proposed to make the cut there at present only 100 feet in width.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Estimate of cost of improvement of James River, Virginia, from canal-locks at Richmond, to and below Goose Hill Flats.

From canal-locks to Rocketts:	
Channel 180 by 15 feet at high water, 20,000 yards, at 50 cents	$10,000 00
Channel 180 by 18 feet at high water, 40,000 yards, at 50 cents	20,000 00
Across Rocketts Reef:	
Channel 180 by 15 feet at high water, 5,000 yards rock, at $4	20,000 00
Channel 180 by 18 feet at high water, 6,600 yards rock, at $4	26,400 00
From Rocketts to lower end Drury's Island:	
Channel 180 by 15 feet at high water, 146,000 yards, at 20 cents	29,200 00
Channel 180 by 18 feet at high water, 320,000 yards, at 20 cents	64,000 00
Dikes, 2,160 linear feet, at $2 20	4,746 00
Across Richmond Bar:	
Channel 180 by 15 feet at high water, 60,000 yards, at 20 cents	12,000 00
Channel 180 by 18 feet at high water, 228,000 yards, at 20 cents	45,600 00
Dikes, 3,000 linear feet, at $2 20	6,600 00
Across Warwick Bar:	
Channel 180 by 15 feet at high water, 25,000 yards, at 20 cents	5,000 00

Channel 180 by 18 feet at high water, 96,000 yards, at 20 cents	$19,200 00
Dikes, 1,350 linear feet, at $2 20	2,970 00
Kingsland Reach:	
Channel 180 by 15 feet at high water, (no excavation)	....
Channel 180 by 18 feet at high water, 20,000 yards, at 20 cents	4,000 00
Dutch Gap, (canal:)	
Channel 100 by 15 feet at high water, 60,000 yards, at 33 cents	19,800 00
Channel 100 by 18 feet at high water, 70,000 yards, at 33 cents	23,100 00
Dikes, 1,000 linear feet, at $5	5,000 00
Trent's Reach, (in event of not using Dutch Gap:)	
Channel 180 by 15 feet at high water, 120,000 yards, at 20 cents	24,000 00
Channel 180 by 18 feet at high water, 200,000 yards, at 20 cents	40,000 00
Dikes, 1,800 linear feet, at $3 50	6,300 00
At Varina or Aiken's:	
Channel 180 by 15 feet at high water, (no excavation)	....
Channel 180 by 18 feet at high water, 48,000 yards, at 20 cents	9,600 00
Dikes, 1,200 linear feet, at $3	3,600 00
Harrison's Bar:	
Channel 180 by 15 feet at high water, (no excavation)	....
Channel 180 by 18 feet at high water, 34,000 yards, at 35 cents	11,900 00

RECAPITULATION.

Channel 180 feet by 15 feet at high water:	
By Dutch Gap	$115,316 00
By Trent's Reach	120,816 00
Channel 180 feet by 18 feet at high water:	
By Dutch Gap	246,716 00
By Trent's Reach	264,916 00

Q 6.

Annual report upon the improvement of the Appomattox River, Virginia, for the fiscal year ending June 30, 1871.

Under the appropriation act of July 11, 1870, such examinations as were necessary were made of this river in August, 1870. It was then found that the city of Petersburgh, through the agency of the Lower Appomattox Company, had appropriated $200,000 for the improvement of the river, according to a plan proposed by Mr. H. D. Bird.

A special board of engineers was organized to consider and report upon the improvement. Their report was printed in Ex. Doc. No. 60, (H. R.) Forty-first Congress, third session.

The board of engineers found a large amount of work already done according to Mr. Bird's plan, the adoption of much of which they deemed it expedient to recommend, for reasons set forth in their report.

In making recommendations for work to be done, the board stated their object to be, to lay down a plan as good as existing circumstances permitted, and such as, with the means likely to be furnished by the General Government and the city of Petersburgh, would result in a decided improvement of the river. It was to give as soon as practicable, chiefly by dredging, a channel 60 feet wide and 12 feet deep at ordinary high water, avoiding as much as possible abrupt bends or long straight reaches, or regulating them where they could not be avoided, and never abandoning the actual navigable channel of the river without strong reasons.

An appropriation of $50,000 was made by the act approved March 3, 1871. A re-examination of the river was made soon after, from which it was discovered that the work had been carried forward to a very considerable extent since the meeting of the board of engineers in

Petersburgh and the publication of their report. The opinions expressed by the board had been practically ignored. It became necessary for the superintendent engineer to reject the work done by the city, or to follow the rule laid down by the board, *i. e.*, to adopt recommendations for further works on the river to its existing conditions, considering what had already been done, and making the best of it, notwithstanding the fact that it did not meet with the approval of the board.

A report was made under date of May 2, 1871, of which a copy is given below:

UNITED STATES ENGINEER OFFICE,
Baltimore, Maryland, May 2, 1871.

GENERAL: Within a few days I have made an examination of the Appomattox below Petersburgh, Virginia, and find that since the meeting of the board of engineers in that city last September, and notwithstanding the opinion of the board was intimated to the president of the Lower Appomattox Company a few days thereafter, that opinion has been disregarded, and the work has been continuously carried on in accordance with the plan of Mr. Bird. The opinion of the board was certainly not obligatory on the city, as the expenditure on Mr. Bird's plan has been borne entirely by the city.

In the report of the board is found the following: "The board do not wish to be understood as saying that the line of which the improvement is recommended in this report would be regarded as the best, if a large sum of money would be available, as required in the progress of the work, and if nothing had been already done in carrying out particular plans. The object has been to lay down a plan as good as existing circumstances permit, and such as, with the means likely to be furnished by the General Government and by the city of Petersburg, will result in a decided improvement of the river."

As the work progresses, the advantage or the necessity of adding to or modifying what has been recommended above may become apparent. Any well-devised scheme of river improvement should be progressive and elastic, and too great haste in executing may result in injuries which more deliberation, joined to careful watching of effects, would have avoided.

Following the principle here announced, but observing that the circumstances are different from those existing when the report was adopted, I have now to suggest a modification of the plan therein laid down.

Referring to the report of the board, I propose that their recommendations, marked 1 and 2, be adhered to, and that thence the *route* laid down by Mr. Bird be followed, without, however, adopting his proposed manner of execution.

It is proper here to state the reasons inducing me to agree now to a departure from a course some time ago approved unanimously by a board of which I was a member. The general explanation is given in the quotation already made from the report of the board. The particular reasons are the following:

It will be observed, on referring to the report of the board, that in the recommendations marked 2, it was proposed to adopt Mr. Bird's line to *e*, "thus making use of the pile-work already executed by him from *d* to *e*." The motives of this adoption are found in previous quotations, in that just made, and in other portions of their report.

Mr. Bird's work has since been carried much beyond *e*. A large sum of money, about $125,000, has been expended upon it by the city of Petersburgh. Some of this money is, it is true, invested in machinery, of which a considerable portion is valuable for future operations.

Although Mr. Bird's scheme of improvement is not approved by all, and although his own expectations of results have not been realized, sufficient evidence has been presented to cause me to believe that a majority of the people of Petersburg, upon whom the burden of this expenditure falls, desire a further trial of Mr. Bird's plan. I think no objection should be interposed to their making this experiment at their own expense, provided the interests of the General Government are protected. The theory of the appropriation of money from the United States Treasury for the improvement of the Appomattox River is, I suppose, that it is a work in which not only Petersburgh is interested, but the whole country.

Had nothing been done on the river at the time of my first examination of it last August, I should have recommended the improvement of the line marked in red on the accompanying Coast Survey map. It will be observed that there is a fine bluff bank on the northern side, as far down as ×, whereas the bold bluff then appears on the southern side at ⊙, nearly opposite, and thence continues on that side towards the mouth of the river, bordering what is known as the south channel. The indications from the map, and more from the river itself, are strong that the route just referred to is the natural channel of the river, and will be permanently the best if re-opened and improved. The portion of the route *below e*, recommended by the board is unquestionably very objectionable on account of its abrupt bends. It was reluctantly adopted by the board, even after the rectifications proposed in their report.

I now wish to expend the late appropriation of $50,000 in dredging in the south channel near the bluff bank, giving a width of 60 feet at bottom, and a depth of 6 or 7 feet at low water, increasing the depth still more if the funds allow, and leaving the city to continue their operations on Mr. Bird's cut through Puddledock Marsh. If the operations of the city give successful results, the improvement of the south channel will add to its usefulness—in fact is essential to it. If the operations of the city end in failure, the re-opened south channel could then be connected by an inexpensive cut, following the natural inclination of the river, with the portion of the present channel which, in Mr. Bird's scheme, is replaced by his cut through Puddledock Marsh. It is therefore requested that authority be given to advertise for proposals for dredging in south channel, commencing at its lower end, in accordance with the recommendation already made.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

A later report was made, as follows:

I have to-day returned from Petersburgh, Virginia, and from a careful examination of the Appomattox River.

The city authorities are confining their operations exclusively to the cut through the Puddledock Marsh. They have been working three dredges, and have nearly completed a cut 60 feet wide, and from 5 to 12 feet in depth at high water.

The opinion of the board of engineers of September, 1870, concerning the Puddledock Cut, may be gathered from their printed report. My own opinion is and has been that that cut was altogether unnecessary. Now, however, that it is nearly completed, and as there seems a strong desire on the part of the community interested in the Appomatox that the cut should be fairly tried, and inasmuch as more than $100,000 of their money has been expended upon it, it seems best to permit its completion.

The funds of the city are running low, and they are very desirous that the benefit of the expenditure of the money of the General Government shall be felt at an early day.

Adhering to the recommendation of my report of May 2, for dredging in the south channel, I propose also to contract for doing a portion of the work in the Puddledock Cut. The city engineer estimates that, at the expiration of thirty days, (the time required for receiving proposals after advertisement,) there will remain about 25,000 cubic yards to be removed from that locality. If the United States assists with this portion of the work, in order to hasten its completion, which is very desirable if it is to be completed at all, and as the completion of this part of the work will liberate the three city dredges for the work in the south channel at an early day, I am inclined to make the recommendation now submitted.

The recommendations of these reports were approved. Proposals have been called for accordingly, and it is expected to begin work actively on the river in a short time.

Expended in fiscal year ending June 30, 1871	$706 30
Available for fiscal year ending June 30, 1872	49,293 70
Required for fiscal year ending June 30, 1873	75,000 00

Q 7.

Annual report on improvement of the Roanoke River, in North Carolina, for the fiscal year ending June 30, 1871.

An appropriation of $20,000 was made for this river by the act approved March 3, 1871. The survey made in the preceding winter showed that the river needed improvement, chiefly in the following particulars, viz: The removal of rocks below Weldon; of wrecks in the lower portion of the river; of shifting bars at several points between Weldon and the mouth, and of snags and overhanging trees at many places.

It was determined to use the appropriation in removing the most troublesome wrecks and other obstructions, which were placed in the stream during the late war; in taking out some of the worst rocks near Weldon, and to apply the balance of the money to cutting off snags and overhanging trees.

Proposals were received May 18, of which an abstract is appended. They were all rejected, as the prices were deemed too high. A contract on reasonable terms was, however, made, under date of June 21, 1871, for removing a number of the most troublesome wrecks. Arrangements will be made for taking out, during the coming winter, some of the dangerous rocks near Weldon, and cutting off some of the snags, &c.

A special report on the Roanoke River will be soon submitted.

Expended during the fiscal year ending June 30, 1871.....	$220 75
Available for the fiscal year ending June 30, 1872..........	19,779 25
Required for the fiscal year ending June 30, 1873..........	25,000 00

Abstract of proposals for removing obstructions in the Roanoake River, as per advertisement of April 18, 1871.

Number.	Name.	Residence.	Price.		Commence.	Complete.	Remarks.
					1871.	1872.	
1	O. E. Maltby........	Norfolk...	$10,500	And wrecks..	July 1	July 1	To remove wrecks, &c., as per advertisement.
2	W. H. Hampton.....	Plymouth.	15,000	And half of wrecks.	....	....	To remove all, as per advertisement, except rocks.
3	George Dick........	Richmond.	18,972	....	June 15	Jan. 15	To remove all, as per advertisement.
4	Hebrew & Asserson.	Norfolk..	11,500	And wrecks..	....	....	To remove all, as per advertisement, except rocks.
5	John M. Foote......	Plymouth.	6,700	Southfield....	July 1	Aug. 1	
			4,700	Schooners....			
			2,000	Battery......			
			400	Piles.........			
			300	Tree.........			
			800	Steamer below Jamesville.			
	Total...........	....	14,900				

Q 8.

Annual report for fiscal year ending June 30, 1871, *for improving mouth of Cape Fear River, North Carolina.*

An appropriation of $100,000 was made for this river by the act approved July 11, 1870. Colonel J. H. Simpson, Corps of Engineers, immediately thereafter made a personal examination of the river below Wilmington, and recommended that "the first important step in any further attempt to improve the entrance of Cape Fear River is to renew the works for the closing of the small inlets in Zeke's Island, and the jettees for the preservation of the outer beach of that island." This recommendation having been approved, work was begun in September, 1870, and has been vigorously continued under the personal supervision of Mr. Walter Griswold, assistant engineer.

The responsibility of this work passed into my hands November 7, 1870. A special report concerning it was made January 23, 1871, which was printed in Ex. Doc. No. 27, Senate, Forty-first Congress, third session.

An additional appropriation of $75,000 was made March 3, 1871. This work is of a class where true economy requires the availability of a large sum of money, and very active expenditure of it. It is a breakwater, intended to close breaches between Smith's and Zeke's Islands, through which a large volume of water passes in and out, with the flooding and the ebbing tide. As the breakwater is extended, the space still remaining for the passage of the water is diminished, but the velocity of the water through the opening still left is greatly increased, and with this, its scouring power. The depth of the open channels are thus increased, and the expense of filling them proportionally.

The estimate of my predecessor for the breakwater was $257,000. This amount would probably have finished the work, if at once appropriated and rapidly expended. That policy not having been pursued, more money will be required for the completion of the breakwater. A special communication will be shortly made on this subject, as also concerning the steps necessary for the further protection of Smith's Island, especially at its lower point, called the "Baldhead," and at other points where the island is very low and narrow, and in constant danger of breaches, under the joint agency of the sea and the winds.

During the year just ended the breakwater and its superstructure have been extended a length of 607 feet, which includes the most difficult and tedious portion, owing to the great depth and velocity of the water. A much more rapid progress of the work, longitudinally, may now be expected. By the end of June, 1872, it will probably be more than 2,000 feet in length.

Besides the construction of the breakwater, attention has been given to the maintenance of existing sand-hills and beaches, and the formation of new ones by the use of cheap catch-sand fences, which have succeeded well. Shrubbery and other vegetation suited to the locality has also been planted and cultivated to advantage with the same object.

This work of improvement is in the collection district of Wilmington, North Carolina. The information given below is reliable, and pertains to the fiscal year just ended.

COIN.		
Duties on imports in American vessels		$8,419 95
Duties on imports in foreign vessels		97,349 68
Duties on imports from warehouse for consumption		23,635 08
Total coin		129,404 71
CURRENCY.		
Hospital dues	$958 06	
Tonnage dues	2,068 69	
Fines, &c	807 61	
Steamboat fees	246 35	
		4,080 71
Total coin and currency		133,485 42

Table of entries and clearances of vessels.

Description.	ENTRIES.		CLEARANCES.		TOTAL.	
	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.	No. of vessels.	Tonnage.
Steamers, coastwise	175	102, 499	165	98, 577	340	201, 076
Sail vessels, coastwise	148	37, 538	28	5. 464	176	43. 002
American vessels, foreign ports	18	2. 887	59	11, 969	77	14. 856
Foreign vessels, foreign ports	29	7, 080	60	14, 773	89	21, 853
Total	370	150, 004	312	130, 783	682	280, 787

Exports to foreign countries.

Description of exports.		Quantity.	Value.
Pitch-pine lumber	feet	8, 334, 054	$154, 096
Railroad ties	ties	13, 833	6, 473
Shingles	shingles	2, 712, 732	15, 152
Cotton	bales	70	4, 413
Spirits turpentine	gallons	1, 531, 283	607. 398
Rosin and turpentine	barrels	80, 789	193, 987
Tar and pitch	do	6, 255	12, 152
Total value			993, 671

The foregoing statements include nothing but direct foreign exports; the larger portion of cotton, naval stores, &c., which ultimately are shipped to foreign ports, are carried by coasting-vessels to Baltimore, Philadelphia, New York, &c., and are credited to those cities. That portion of these articles not intended for home consumption could be shipped direct to their destination if deeper water existed on the bars at the mouth of the Cape Fear River, so as to enable large vessels of greater draught to enter.

Below is a statement of the exports from this district to all parts of the world during the fiscal year ending June 30, 1871. This statement is compiled from the records of the Chamber of Commerce of Wilmington. The principal articles only are given:

Casks of spirits of turpentine	95, 098
Barrels of crude turpentine	15, 100
Barrels of rosin	475, 548
Barrels of tar	24, 500
Barrels of pitch	7, 100
Bales of cotton	60, 210
Bales of yarn	115
Bales of sheeting	650
Bushels of peanuts	98, 700
Bushels of rough rice	3, 110
Lumber, pitch pine, feet, board measure	18, 085, 450
Timber, pitch pine, feet, board measure	275, 000
Shingles	8, 340, 100
Cypress staves	495, 075

Below is a comparative statement of foreign and coastwise shipments from this port for the past fiscal year, compiled from the two statements above:

Description of articles.	American ports.	Foreign ports.	Total.
Pitch-pine lumber....feet..	10,026,396	8,334,054	18,360,450
Shingles....number..	5,627,368	2,712,732	8,340,100
Cotton....bales..	60,140	70	60,210
Turpentine....gallons..	2,272,637	1,531,283	3,803,920
Rosin and turpentine....barrels..	409,859	80,789	490,648
Tar and pitch....do....	25,345	6,255	31,600

Large quantities of iron, copper, and other metals, and coal, are found in the valley of the Deep River, and Upper Cape Fear River. These are of excellent quality, and are easily procured. Three important railroads converge at Wilmington.

An appropriation of $150,000 is requested for the service of the fiscal year ending June 30, 1873.

Expended in fiscal year ending June 30, 1871	$102,514 18
Available for fiscal year ending June 30, 1872	72,485 82
Required for fiscal year ending June 30, 1873...........	150,000 00

Q 9, (1.)

Annual report upon the improvement of Queenstown Harbor, Maryland, for the fiscal year ending June 30, 1871.

A survey of the harbor was made in November, 1870, the results of which were submitted in my report of January 2, 1871.

The improvement needed was the dredging of a channel in Queenstown Creek, 100 feet wide at bottom and 8 feet deep at mean low water, at an estimated cost of $9,500.

An appropriation of $5,000 was made by the act approved March 3, 1871. It was determined to expend this appropriation in making a channel 8 feet deep, and as of great width as the funds would allow. Proposals were called for by advertisement of March 20, 1871. An abstract of those received is appended. A contract was made with Mr. John W. Parks, dated April 26, 1871. Work under the contract is now progressing favorably, and will be completed this season.

If the amount of the original estimate had been appropriated in one sum, the work would have been thereby completed. To commence an improvement of this kind, and then suspend it for many months until a new appropriation becomes available, adds greatly to the total cost.

Queenstown is situated in the collection district of Baltimore, which is the nearest port of entry.

The report of January 2, 1871, which is printed in Ex. Doc. No. 60, Forty-first Congress, third session, (H. R.,) indicates the present and prospective commercial importance of this harbor.

Expended during the fiscal year ending June 30, 1870	$2,635 20
Available for expenditure in fiscal year ending June 30, 1872.	2,364 80
Required to complete the work in year ending June 30, 1873.	6,000 00

Abstract of bids for excavating channel at Queenstown, Maryland, as per advertisement of March 20, 1871; opened at 12.10 p. m., April 22, 1871.

No. of bid.	Name and address of bidder.	Time of beginning.	Time of completion.	Number and kind of machines.	Price per cubic yard.
					Cents.
1	John W. Parks, Norfork, Va	May 10	July 30, 1871	Osgood	*35
2	Morris T. Brainard, Albany, N. Y	June 15	August 1, 1871		38
3	Franklin B. Colton, Philadelphia, Pa	May 20	July 1, 1871		35

* To be measured in scows.

Q 9, (2.)

BALTIMORE, MARYLAND, *January* 2, 1871.

GENERAL: A survey of the harbor of Queenstown was made under the direction of my predecessor, Colonel J. H. Simpson, Corps of Engineers, by Mr. William Popp. I transmit a copy of the map of his survey and of his report, dated December 29, 1870. Reference is requested to the Coast Survey chart, transmitted with my report of this date on the improvement of the harbor of Cambridge. Reference is also requested to Martenet's map of Maryland.

Arrangements are in progress for connecting Queenstown, by rail, with existing lines in its vicinity. When these are completed its commercial importance will be doubtless much increased.

Mr. Popp estimates that to give a channel-way of 100 feet in width and 8 feet in depth at mean low water would cost about $9,500. I approve his report and estimate.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

BALTIMORE, *December* 29, 1870.

MAJOR: In compliance with your verbal order, I have the honor to submit the following report on the survey of the harbor of Queenstown, Maryland, made by me, assisted by Mr. Charles J. Bates, from November 2 to November 9, 1870, inclusive:

The operations at this place were carried on in a manner so similar to that observed at Cambridge, that I can confine myself to merely stating that all the data furnished by this survey and mapped in the accompanying plat, possess equal claims to correctness and reliability as those of Cambridge.

Moreover, the geological character of the vicinity of Queenstown, the nature of the bottom of the creek and river, &c., are such that a description of them would simply be a repetition of what has been said about Cambridge.

Queenstown is situated on Queenstown Creek, an estuary of the Chester River, about ten miles from the mouth of the latter. The distance from Baltimore to Queenstown is about thirty-six miles. The town belongs to Queen Anne's County, and is said to be the most important mail station of the county. The mail is brought from and carried to Baltimore by a line of steamers, which arrive from Baltimore every other week-day, and return the following day. These steamers carry also a considerable number of passengers and some freight. The freight consists principally of oysters, fish, fowl, cattle, and country produce generally. Peaches and grain are said to form another considerable item of export. In ordinary cases the steamers land at the wharf marked Mitchell's wharf on the sketch, but in cases of rather low tide the passengers, &c., have to be brought ashore in a small boat.

confining it on both sides, but to this must be added the fac
densely covered with grasses over 1 foot high, and that they the
barrier to the flow of water over them. A direct proof of what h
spect to the flow of ebb-tides cannot be furnished, as the current
plated by me, were prevented by high winds prevailing at the ti
of the harbor of Queenstown is based not so much on the com
the place as on the fact that it is the only harbor, within some d
the Chesapeake Bay, which vessels could make in gales, principal
northwest to northeast. It is asserted by competent parties that
the entrance of Chester River is not distinguishable from the bay
quently driven into it unawares; that in it they must make a har
Queenstown or be lost, because a return to the bay and a further
River are equally impossible. A glance at an accurate chart of
and Chester River will show the truth of the last remark. The
of a large schooner, lying at the southwest side of the channel, fu
of the same fact. This schooner, in company with three or four o
the Chester River and attempted to make the harbor of Queenst
panions. Two of the lot got wrecked; the rest succeeded in gain
deepening and buoying out of the channel would, from this consi
sirable indeed.

The proposed improvement consists in a channel 100 feet wide
at mean low water, and having slopes of 2 base to 1 perpendicu
indicated on the sketch by red lines, and follows the existing chan
ble with the necessary straightness. Two slight curves occur in i
and one at the inner end of the channel. The excavation nec
amounts to 27,000 cubic yards. It is assumed that contracts will
vate and dump the material in the Chester River, at a cost of 3
this figure, the expense for dredging would amount to $9,450, o
$9,500.

It does not seem necessary to secure the channel from filling i
sive jetties, &c., the probability being (unless the writer mista
the locality and the influence of the various agencies to be consi
nel will maintain itself in its dimensions for a long time to come.

I am, major very respectfully, your most obedient servant,

WI

Major W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

1871. It was determined to expend this appropriation in dredging, providing as good an entrance and harbor, of the depth of 9 feet, as the funds would allow.

Proposals were called for by advertisement of March 21, 1871. An abstract of those received is appended.

A contract was made with the lowest bidder, Mr. G. H. Ferris, of Brooklyn, New York. Work is now progressing favorably under the contract, and will be completed this season as far as the existing appropriation permits.

A channel 100 feet in width, to the mouth of the creek, and a channel 50 feet in width in the creek, to the railroad wharf, will be completed, and the remainder of the appropriation will be applied to the improvement of the exterior harbor, and to the interior basin.

Cambridge is situated in the collection district of Baltimore, which is the nearest port of entry.

The report of January 2, 1871, which is printed in Ex. Doc. No. 60, Forty-first Congress, third session, (H. R.,) indicates the present and prospective commercial importance of the harbor.

Expended during the fiscal year ending June 30, 1871	$2,474 57
Available for expenditure in year ending June 30, 1872....	7,525 43
Required to complete the work in year ending June 30, 1873.	20,000 00

Abstract of proposals received for dredging at Cambridge, Maryland, as per advertisement of March 21, 1871; opened at 12.10 p. m., April 24, 1871.

Number of bid.	Name and address of bidder.	Time of beginning.	Time of ending.	Kind and number of machine.	Price per cubic yard.	Remarks.
					Cents.	
1	John W. Parks, Norfolk, Va.......	July 1, 1871	Oct. 1, 1871	......	34¼	Or on completion of Queenstown work.
2	N. G. Dodge & Brothers, Cleveland, Ohio.	June 10, 1871	Dec. 1, 1871	......	31	
3	American Dredging Company, Philadelphia, Pa.	June 1, 1871	Sept. 1, 1871	......	29	
4	Gilbert H. Ferris, Brooklyn, N. Y..	June 1, 1871	Aug. 15, 1871	......	27	Or $9,000 for whole work.

Q 10, (2.)

BALTIMORE, MARYLAND, *January* 2, 1871.

GENERAL: A survey of the harbor of Cambridge, Maryland, was lately made under the direction of my predecessor in charge of that work, Colonel J. H. Simpson, Corps of Engineers. The map has been completed since his departure from this station. It is transmitted herewith.

Cambridge, the county seat of Dorchester County, is situated about eighteen miles from the mouth of the Choptank River, on the eastern shore of the Chesapeake Bay, in the State of Maryland, about seventy miles from the city of Baltimore. Its population is about 1,800. Its communication with Baltimore is maintained by a line of steamboats. It is also the terminus of the Dorchester and Delaware Railroad, which connects it with the railroad system of the State of Delaware, and brings the town into direct communication by rail with the principal Atlantic cities. This town is much interested in the construction of the wharf proposed at Lewes on Delaware Bay, which is regarded as an important adjunct to a direct trade with New York City.

The Choptank is a fine river; twenty-five feet of water can easily be carried for a considerable distance above Cambridge. Its banks and back country are in a high state of cultivation. Large quantities of peaches, grain, ship timber, and other timber are said to be transported on it, being the product of the adjacent country. Cambridge has considerable advantages for engaging in ship-building. It is an enterprising place, whose importance would be greatly increased if the assistance of the General Government could be given toward the improvement of the harbor and its entrance.

It is estimated that, to give a suitable entrance-way, with a depth of 8 feet at mean low water, and to provide sufficient harbor accommodations of the same depth, would require the removal of 54,000 cubic yards of material. The probable cost, at the rate of 40 cents per cubic yard, would be $21,600. To give a depth of entrance and harbor of 10 feet at mean low water, would cost about $36,000.

I transmit herewith a report, dated December 22, 1870, from Mr. William Popp, assistant engineer, by whom the recent survey was made.

A Coast Survey map is forwarded, showing how Cambridge is situated relatively to Chesapeake Bay. Reference to Martinet's map of the State of Maryland is also requested.

Cambridge is stated to have once had a direct trade with Europe. Detailed statistics as to its present trade, wants, and capabilities have been promised me, but up to the date of this report have not been furnished.

I inclose also a copy of a memorial prepared for the consideration of Congress, and a copy of an article prepared by one of the most active citizens of Cambridge, both going to show the importance to the General Government of the improvement of the harbor of Cambridge.

Very respectfully, your obedient servant,

WILLIAM P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

BALTIMORE, *December* 22, 1870.

MAJOR: In compliance with your verbal order given to me, I have the honor to submit the following report on the survey of the harbor of Cambridge, Maryland, made by me under the direction of Colonel J. H. Simpson, Corps of Engineers, United States Army, from October 21 to October 27, inclusive, assisted by Mr. Charles J. Bates.

In order to give a criterion of how reliable and accurate the data furnished by this survey may be considered, I will give a short description of the main operations.

A base-line of 429.58 feet in length was measured carefully several times by means of a steel tape-line of known accuracy. From this base-line, which extended from one end of the bridge to the other, nineteen points in the creek were determined by goniometer observations; five observations were made for each angle. Two of these points, which were intended for use as stations, were located by twenty observations. From these secondary stations, seventeen points were located on both sides of the channel leading to the creek, in the same manner as those in the creek. Secondary rows of poles, consisting of three each, were then placed in the intervals and outside of the line of the first rows, and were located by sextant observations from the main poles. Lines of soundings were then taken by rowing exactly in range of some two of the poles, and each sounding was located by a sextant observation on a third pole. The whole ground to be considered in the question of improving the harbor was, in this manner, covered with a net-work of soundings so dense that more than one-half of the soundings taken had to be thrown out, in order to render the plat less crowded with figures, and more intelligible.

A tide-register was kept at the south end of the bridge from October 20 to October 27, inclusive, daily from 7 o'clock a. m. to 5 o'clock p. m. The mean of the eight low tides observed was considered as mean low water, and it is believed that this assumption does probably not vary much from the truth, although the number of observations was very limited, because no extraordinary tide occurred during the time, and the variation between the various low tides observed was rather small.

The nature of the bottom was examined by thrusting an iron-shod pole into it as deeply as the circumstances would admit.

The results of the survey are mapped in the accompanying plat. To judge of the accuracy of the data given in it, it should be observed that the thirty-six points mentioned above were located by distances. Two distances from the stations and one from some other pole were in each case used. The distances were calculated by myself and my assistant, independently of each other, and the exact agreement of the results thus obtained insured perfect reliability. The soundings were located by plotting the observed angles. Not more than one-half the soundings actually taken are, as above mentioned, given in the chart. The blue curves represent the contour of the bottom, their vertical distance from each other being 2 feet.

The geological formation of the vicinity of Cambridge is an alluvial one. The main ingredients of the soil are sand and loam, and, to a small extent, fine gravel. The bottom of the Choptank River shows the same component parts, with the addition of a large amount of oyster-shells. The knolls characteristic of oyster-beds are found in profusion in the vicinity.

The Choptank carries very little sediment in suspension along with it, a fact which seems to follow from its great transparency, for which it received its name.[*] The amount of material pushed along on its bottom could not be considerable, as the bottom is generally very hard and well packed. From these considerations, if they be correct, it would follow that a filling up of a prospective channel in this place, for reasons to be found in the general character of the river, need not be feared. The immediate vicinity of the channel, however, is of such nature as to attract our attention seriously.

The shore east of the creek is receding from the effects of erosion, caused by the action of waves, principally during high winds ranging from northwest to northeast. There is good reason to believe that the material washed away at that place has been deposited in the vicinity of a place marked C on the chart. There is at that place a thin stratum of sand, and below it soft mud, showing unmistakably that this superincumbent layer was brought there at a period not very remote.

Cambridge Creek is at the head of a small recess or bight of the Choptank, the angle of the shore-lines, below and above the creek formed at the mouth of it, being 125°. The mean depth of water in the unimproved portions of the creek is about 4½ feet. The bottom consists of very soft mud and sand and loam. The mud is of variable depth, increasing from a few inches in the vicinity of the shores to an indefinite depth at the center. Poles were pushed down at the center 8 feet into the bottom without reaching hard ground, and it was told me that the piles of the bridge had been driven 15 feet into mud without striking a solid foundation. There is a spot of limited extent in the vicinity of the railroad wharf where a thin stratum of iron ore was discovered by dredging operations carried on at the place a year ago.

This short description of the locality will serve, in connection with the chart, to furnish the necessary data for proposed improvements.

It should be mentioned here that the inhabitants of the place formed a company in 1868 for the purpose of improving their harbor. About $8,000 were raised, and have been expended (last year) in deepening the channel leading to the creek and the creek itself. A sort of jettee was also built on the east side of the entrance, in order to prevent the filling in of the channel from this side.

After a careful study of all the data derived from the accompanying chart and examinations made on the locality, I would propose the following improvements to be made there, in case Congress is of the opinion that the commercial importance of the place, &c., warrant the necessary expense:

1st. A channel 100 feet wide and 10 feet deep at mean low water, in the direction indicated by red lines on the chart.

2d. The deepening of the interior of the creek, within the red lines of the chart, to a depth of 10 feet at mean low water.

3d. The filling of the sediment excavated in wharves, to be built by citizens of the place at their own expense and under the direction of the Government.

The location of these wharves is indicated on the chart in red. The expenses to be

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[*] Choptank, expressed in English, would be "Clear Water."

Major W. CRAIGHILL,
Corps of Engineers, U. S. A.

The war now raging between Germany and France has serv
the world to the great changes that have taken place in the
war. Apart from the peculiar system by which Prussia has m
citizens, the great changes in the material of war, the entire rev
system, together with the changes due to the use of the telegr
for all nations to study these new conditions carefully, and see h
is threatened, or how it is prepared to meet and to resist such nov
binations. The far-reaching arms, muskets, and field artiller
trains, with their ponderous projectiles, the field-telegraph, si
system of transportation, all affect the older war systems; but
discovery of the enormous military power of a nation when d
developed, as has been done by Prussia, we need not be so m
critics are, at the ability of Von Moltke to collect always, at
overwhelming masses of troops, and at the unvarying success o
in all their encounters with the hitherto military nation of Fra

This country, in its failure to fortify its large cities, and its ge
prehensive and co-operating system of defensive works of all k
deliberately to reliance upon other means of defense, or is cul
great duty of a nation—its own protection against assaults fro

We assume for the present that the Government is satisfied o
intends to rely for its own salvation upon the people, upon
sacrifice, their loyalty, and patriotism. In other words, that in
the Government will appeal to the people, confident of fa
response.

Now, would it not be wise, in view of the possible contingency
necessary preparations for the utilizing of this great force of the
out large bodies of men for instruction? Should not the greates
the ways of travel in every direction, encouraging, as much as
prise in the development of the country, but the Governme
strengthening its military position and resources, and by this
sight anticipating all surprises.

Prominent among these secondary means is the provision for t
of troops and material of war. Many splendid exhibitions of t
nation were given during the late war, but they were given at
and risk frightful to contemplate. Attention to such matters

At such a crisis a way by the bay is the most natural, and in 1861 was perceived and adopted.

By the bay no way from the North, for heavy transport, is so direct, and expeditious, and economical, as by Lewes, Delaware, to the Choptank River, across the Eastern Shore Peninsula. From New York and Philadelphia troops landed at Lewes could be transported to Cambridge in two hours, and to Annapolis in two more, and to Washington in one hour and a half.

The value of this route would be acknowledged in case of a blockade of the mouth of the bay, or even of the mouth of the Potomac River. While troops could be sent by rail from Philadelphia, the necessary transportation of supplies, &c., would demand other routes, and none could compare for this purpose with this same line, *via* Lewes, Delaware, and the Choptank River.

A safe harbor of sufficient depth at Cambridge, where the river is two miles wide, is all that is necessary to develop and secure this short but important military line. Should the noble oak timber of this region ever be required for vessels of war, this same harbor, as the outlet of a canal of only 10 miles in length, connecting the waters of five rivers, reaching to the Fishing Bay, would be absolutely necessary, and would thus become of immense value to the naval defenses of the country.

To the honorable the Senate and House of Representatives of the United States of America:

The petition of the undersigned respectfully represents that at a meeting of the citizens of Cambridge, Maryland, held on the 19th of May, 1870, convened to take into consideration the subject of the improvement of the harbor of Cambridge, they were appointed a committee to memorialize your honorable bodies for an appropriation of $50,000 to aid in carrying out this purpose. They further represent that, by an act of assembly of Maryland, passed at the January session, 1868, chapter 143, the Cambridge Harbor, Internal Navigation, and Wharf Company was incorporated, with the power, among others, "to open, enlarge, and deepen a channel or canal across the bar or obstructions in the Choptank River in front of the town of Cambridge and the present wharf, and into the Cambridge Creek, to the head thereof; to clear out the said creek and channel to any width and breadth that may be deemed necessary or expedient for a safe and convenient harbor for steamers or any other vessels, and to erect wharves at the end of any of the streets in the town of Cambridge running down to said creek where no wharves are now constructed, and make proper channels leading thereto." But your petitioners are advised that it would be for the advantage of said company to receive a charter of incorporation from Congress, and have their powers confirmed thereby. The undersigned would, therefore, respectfully pray that the provisions of said act of assembly be confirmed by your bodies, together with the powers thereby conferred upon the said company. The company chartered by the legislature of Maryland has already expended, in carrying out the purposes of its incorporation, the amount of capital stock hitherto subscribed, but the sum has been found greatly inadequate to a thorough completion of the work. And having so expended the amount of their stock and failed to complete the work, the whole object—which is one of vast importance to our people—may be permanently defeated without the aid of Congress.

In asking for this charter and the above-named appropriation of $50,000, your petitioners would suggest that the beautiful town of Cambridge is susceptible of being made a port of considerable importance, in a commercial point of view, owing to its railroad connection with all parts of the peninsula, composed of Delaware and the Eastern Shores of Maryland and Virginia, and also its proximity, in point of time, to Baltimore and all points on the Chesapeake Bay. They would suggest, too, that it is a place where ship-yards could be located by the Government with great profit. Our woodlands abound in timber which can be used in the construction of ships of every grade and character, and by locating yards here the Government would save the immense cost of transportation to distant ship-yards. Hundreds of thousands of feet of timber from our county have been worked up in the ship-yards of the North, and it has been uniformly pronounced among the best ship-timber of the country. For the construction of marine railways, the location of docks for repairing, and as a place of rendezvous for cutters and ships off duty, we think it presents decided advantages. The location is an extremely healthy one, and would afford every convenience and pleasure to the operatives, while its proximity to the Chesapeake Bay (and also to the capital of the country) would afford every facility for co-operation with bases of naval operations on the Atlantic coast.

The only difficulty in the way of these things is the shallowness of the water just in front of the town of Cambridge, which it is now proposed to deepen and render available for navigation by any vessels. The Cambridge Creek would afford ample room and a secure harbor for a considerable amount of shipping.

The advantages of the proposed work to the people of our section (as well as to the

Government, should it avail itself of them) must be apparent; and we are the more encouraged to ask this appropriation from the fact that, with one exception, there has never been an appropriation by the General Government toward the advancement of the Eastern Shore of Maryland.

Very respectfully,

PHILIP D. LAIRD,
JAMES WALLACE,
W. WILSON BYRN,
LEWIS ROSS,
CHAS. F. GOLDSBOROUGH,
CALEB SHEPHERD,
Committee.

Q 11.

Annual report for the fiscal year ending June 30, 1871, *for examinations and surveys for improvements of rivers and harbors on the Atlantic coast.*

SURVEY OF THE WICOMICO RIVER, NEAR SALISBURY, MARYLAND.

A resolution of the House of Representatives, dated February 3, 1871, directed a survey of this river, which was undertaken and completed as soon as possible by Mr. William Popp, assistant engineer. My report, transmitting Mr. Popp's report and map, was submitted on the 15th of April, 1871.

EXAMINATION AND SURVEY OF THE JAMES RIVER AND KANAWHA CANAL.

This survey was directed in the appropriation bill approved July 11, 1870. The field-work was begun as soon as practicable thereafter, two parties being organized and continued as late as the weather and funds permitted. To Mr. William R. Hutton was assigned the duty of ascertaining the best manner, if any existed, of continuing the communication by water, from the end of the old canal to the waters of the Ohio River.

Mr. Walter Gwynn Turpin was placed in charge of the examination of the line of the canal from Richmond to Buchanan, with a view to a determination of the cost of its enlargement to a size which would adapt it to the extended use it would receive when it became a link in the great central water-line between the Atlantic slope and the valley of the Mississippi. A report with estimates was submitted under date of January 27, 1871, which was printed in Ex. Doc. No. 110, H. of R., Forty-first Congress, third session.

SURVEYS OF ACCOTINK, NEABSCO, QUANTICO, AND CHOPPAWAMASIC BAYS AND OF AQUIA CREEK.

Directed in the appropriation bill of March 3, 1871.

The field-work has been under the immediate supervision of Captain C. B. Phillips, Corps of Engineers, and will be completed in July, 1871. The preparation of the reports, maps, &c., will be at once begun, and they will be submitted at an early day.

EXAMINATION AND SURVEY OF THE ROANOKE RIVER, IN NORTH CAROLINA.

This survey was directed in the appropriation bill approved July 11, 1870.

The lateness of the season, and its unhealthiness, caused a postponement of field-work until frost. A preliminary report was made, dated January 17, 1861, which is printed in Ex. Doc. No. 60, part 2, H. of R., Forty-first Congress, third session. An appropriation of $20,000 for the improvement of the river was made by the act approved March 3, 1871, the disposition of which is treated of elsewhere, under the head of the improvement of the Roanoke River. A report and map of his survey were submitted to me by Mr. George H. Elliot, the assistant engineer, under date of April 28, 1871. This report and map will be shortly forwarded.

SURVEY OF THE NEUSE RIVER BELOW GOLDSBOROUGH, NORTH CAROLINA.

This survey was directed in the appropriation bill approved March 3, 1871.

Field-work was begun by a party under Mr. William Popp, assistant engineer, on the 18th of April, 1871, and completed in June. The preparation of the report and map is progressing. They will be soon completed and submitted.

SURVEY OF CAPE FEAR AND DEEP RIVERS, AS FAR UP AS LA GRANGE, NORTH CAROLINA.

Directed in the appropriation bill of March 3, 1871.

The survey was begun at La Grange, in June, 1871, by Mr. George H. Elliot, assistant engineer, and will be completed by the end of September, 1871, when the preparation of the report and map will be begun. They will be submitted by the end of the current calendar year, 1871.

Q 12.

UNITED STATES ENGINEER OFFICE,
Baltimore, Maryland, April 15, 1871.

GENERAL: The resolution of February 3, 1871, of the House of Representatives, of which a copy was inclosed with your letter of February 8, 1871, requiring a survey of the Wicomico River near Salisbury, Maryland, was in the following words:

> CONGRESS OF THE UNITED STATES.
>
> FORTY-FIRST CONGRESS, THIRD SESSION.
>
> IN THE HOUSE OF REPRESENTATIVES,
> *February* 3, 1871.
>
> On motion of Mr. Hambleton,
>
> *Resolved*, That the Secretary of War be, and he is hereby, requested and directed, as soon as practicable, to cause to be made a survey of Wicomico River at and near the town of Salisbury, Maryland, with a view to determine the practicability and expense of clearing out and removing the bar in said river at said town.
>
> Attest:
>
> EDW'D McPHERSON, *Clerk.*

The survey was energetically undertaken as soon as practicable after the receipt of the order, and has been satisfactorily completed by Mr. William Popp, whose report, forwarded herewith, has my approval. Attention is invited to this report, its appendices, and accompanying map.

It does not seem necessary to say anything further in connection with the Wicomico at this time, except to give such of the information called for by the circular of June 10, 1868, from headquarters of the Corps of Engineers, as is not supplied by the report of Mr. Popp and its appendices.

The sum of $17,000 can be profitably expended upon the improvement during the next fiscal year.

The work is situated in the collection district of Baltimore, which is also the nearest port of entry. The amount of revenue collected at Baltimore for the last fiscal year is stated to be $9,113,718 58.

It is believed that an expenditure of about $3,000 every fifth or sixth year will suffice to maintain a channel of the capacity recommended.

Very respectfully, your obedient servant,

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

BALTIMORE, MARYLAND, *April* 10, 1871.

MAJOR: I have the honor to submit the following report on the survey of the Wicomico River, at and below Salisbury, Maryland, made by me, under your direction, from March 2 to March 9, inclusive.

Salisbury is situated on the Wicomico River, about twenty miles from its mouth. It is the county seat of Wicomico County, and apparently a very thriving place. The lumber trade, which during my presence in town seemed to be the only trade of importance carried on, is very extensive. The facilities for mills driven by water-power are fine; the land in the vicinity, as far as I had an opportunity of seeing it, is heavily timbered.

The town is a station of the Wilmington and Pennsylvania road, and the terminus of the Wicomico and Pocomoke, which latter is chiefly engaged in freighting timber and lumber to Salisbury. The export lumber trade is carried on almost exclusively on the Wicomico, but great difficulty is at present experienced in shipping it, because the head of navigation is about one and a half miles below town. It is this portion of the river, extending from town to head of navigation, which the inhabitants of the place desire to improve.

The survey of the river was conducted with as much care and exactitude as circumstances would permit.

Tidal observations were made during seven days at the bridge, and mean low water determined from them. The results of the survey are plotted in the accompanying map.

The Wicomico is a small river, flowing through a flat country; its banks are, to a great extent, marshy; its bed muddy. Its width is exceedingly great in comparison to the other elements of its regimen. In this latter circumstance may be found one of the most fruitful sources of deterioration of the portion immediately below town. The bottom of the river consists of loose sand, mud, and saw-dust, in about equal proportions. This composition of the bottom points to another cause of deterioration. The saw-mills situated farther up stream have contributed largely, though involuntarily, to injure the river below town; a great portion of their saw-dust got overboard, and was carried down stream by the rapid current of the mill races. Arriving at the position of the river where the undue expansion of its bed reduced its velocity to a minimum, and after having much of the air contained in the woody fiber expelled, the particles could not be carried any further in suspension, but were deposited on the bottom.

With a view to arrive at an intelligent estimate of how great the width of the river should be in order to maintain a depth of 7 feet at mean low water, I gauged the river on a line A B, marked on the map, at about three-quarters ebb, on a day when there was rather a strong ebb tidal current. The result was: Cross sectional area, 239.5 square feet; mean velocity, .73 feet per second; volume of discharge, 174.8 cubic feet per second. These figures are not exact, being based only on one current observation, but they may be considered as a near enough approximation. Taking them as a basis of calculation, we find that the river is able to fill a channel of 50 by 7 feet with a velocity of .5 feet per second, or a channel of 75 by 7 feet with a velocity of .33 feet.

Starting from the opinion that any improvement of the river, in order to be somewhat permanent, must include the reduction of the width of its bed to the figure as calculated, I took pains to ascertain whether the owners of property along the banks of the river, who would chiefly be benefited by the improvements, were willing to contribute their share by building suitable dikes along the proposed banks of the river. The result of my endeavors was a declaration, signed by all property holders on the river, signifying their willingness.

The proposed improvements consist in—

1. Dredging a channel 75 feet wide at water's edge, 7 feet deep at mean low water, from bridge to head of navigation.
2. Building dikes on both sides of this channel, as indicated on accompanying map, to receive the material excavated.

A tide-lock might, with little expense, be arranged at the bridge connecting Main street and Quantico County road. The head of water to be obtained there would be about 2 feet, and the channel might, at least to some extent, be scoured by opening at low water. It is, however, not contemplated proposing any such measure at the present time.

Dredging will certainly be required periodically, in order to keep the channel clear, as all the sediment cannot be carried below the improved position by the current. It is, however, believed that with the necessary care, the amount of sediment can be reduced to very small limits. It at present consists chiefly of saw-dust. One of the saw-mills has a "patent blower" already in operation, the object of which is to remove every particle of saw-dust from the saw when in operation, thus preventing its falling overboard and obstructing the channel, and I was assured that all the saw-mills now in operation would shortly follow this example.

The excavation necessary to obtain a channel 75 feet wide at water's edge, with slopes of 2 base to 1 perpendicular, amounts to 68,000 cubic yards. It is believed that bids to remove the sediment at 25 cents per cubic yard can readily be received. At this price, the cost would amount to $17,000.

Appendix A, accompanying this report, contains statistical data collected by Mr. George W. Parsons, a gentleman of great ability and undoubted veracity.

Appendix B is the declaration of property holders, above referred to.

I am, major, very respectfully, your most obedient servant,

W. POPP, *Assistant Engineer.*

Major W. P. CRAIGHILL,
Corps of Engineers, U. S. A.

A.

Salisbury, the county seat of Wicomico County, Maryland, is situated at the head of Wicomico River, on the Peninsular Railroad, one hundred and thirty miles from Philadelphia, and is the terminus of the Wicomico and Pocomoke Railroad. Surrounded by good farming lands, and adjacent to large bodies of timber and numerous steam and water saw-mills, it is the center of a very extensive lumber, wood, and grain trade. Its recently-completed railroad facilities, the number of mills and factories in process of erection in the town and vicinity, and enterprise of its merchants, give sure indications of present prosperity and ultimate increase in business, population, and wealth. It has 10 churches, 3 newspapers, 7 white academies and schools, with 394 pupils, 1 colored school, with 200 pupils. It has 3 water and 1 steam saw-mill, with capacity for manufacturing 2,700,000 feet of lumber; 2 planing mills, which will dress 3,000,000 feet of flooring and manufacture 60,000 fruit-boxes and 450,000 plastering laths; 2 large grist mills, capable of grinding 54,000 bushels of grain per year. The assessed value of real estate within the corporate limits is $600,000. Twenty-one schooners, with a registered tonnage of 1,099 tons, and a large number of smaller vessels, trade regularly from the town. One hundred thousand bushels of oyster shells and lime, and 1,000 tons of other fertilizers, are annually sold to the farmers. The average yearly shipments are, of lumber, 12,850,000 feet; of wood, 10,550 cords; 21,000 railroad ties, and 94,500 bushels of grain. The merchants have $245,000 invested in trade, and their annual sales amount to $691,800.

Two years of excessive rains and one year of drought have decreased the shipments of grain one half. The indications are a large increase in this, as well as other branches of the trade of the place.

In addition to the foregoing, many thousand crates of peaches and berries, barrels of apples, potatoes, and eggs, and quantities of lumber and shingles, are shipped over the Peninsular Railroad to Philadelphia and New York, exact amounts of which are not known. The freight receipts to the railroad company from these sources will amount to $1,200 per month per year.

Nearly all the shipments from Salisbury are by water. Owing to the shallowness of the stream for a mile from the town to the harbor, navigation is conducted under difficulties and great expense at the present as compared with former times. In the recollection of old inhabitants, schooners sailed from Salisbury to the West Indies, loading and discharging their cargoes at a point above the bridge, now the extreme upper limits of our wharves. Since then, freshets occurred sufficient in force to wash away the sand dams which backed the waters of the river at the saw-mills, resulting in filling up the existing channel and changing its course in such a manner that the velocity of the water flowing sluggishly over a flat bed is not sufficient to remove and carry down stream the saw-dust from the mills and other débris finding its way into the stream, as it formerly did. Consequently, deposits of this nature have accumulated to such an extent as to prevent the use of shallow lighters, except during the higher stages of the tide.

It is proposed, with the assistance of the General Government, to deepen the present shallow channel and erect dikes on its banks, to so confine the whole volume of water flowing in the stream to the new channel, thereby preventing the deposit of any of the materials with which it is now obstructed. Such an improvement would be of immense benefit to the town and to the large section of country dependent upon it for an outlet for their productions.

It would be a permanent improvement, as the original cause of obstruction, the washing away of temporary sand dams, has been effectually prevented by the erection, by the mill owners, of substantial overfall dams of masonry, instead of the former uncertain structures, amply sufficient to resist double the force of any known freshet. These freshets, if held back by the mill-dams, invariably flow off without damage to property, having the effect, in the most severe ones, of making a difference of about one foot more in height of our tides during its continuance.

Very respectfully,

GEO. W. PARSONS.
E. E. JACKSON & CO.
THOMAS F. RIDER.
PURNELL TOADVINE.
SAM'L A. GRAHAM.
THOS. HUMPHREYS.
H. HUMPHREYS.
W. BIRCKHEAD & CO.

Q 13, (1.)

UNITED STATES ENGINEER OFFICE,
Baltimore, Maryland, January 27, 1871.

GENERAL: The law of July 11, 1870, authorized the survey of the James River and Kanawha Canal. On the 25th of July notice was received that the charge of that survey, with others, as well as of several works of river and harbor improvement, had been committed to me.

The object of the survey was to throw additional light upon the questions, 1st, of the practicability, and, 2d, of the cost, if practicable, of opening a continuous line of navigable water between Richmond, Virginia, and the Ohio River, which would admit of almost unlimited extension by the James and Ohio Rivers and their connecting waters.

The season for field-work was already far advanced at the date of the passage of the law. Some time was necessarily consumed in securing the services of suitable persons, to whom might be given the charge of the survey, from participation in which I was excluded by other duties.

The work naturally divided itself into two parts, and two parties were speedily organized. Mr. Walter Gwynn Turpin was placed in charge of the examination of the line of the canal from Richmond to Buchanan, with a view to a determination of the cost of its enlargement to a size which would adapt it to the extended use it would receive when it became a link in the great central water-line between the Atlantic slope and the valley of the Mississippi.

To Mr. William R. Hutton was assigned the duty of ascertaining the best manner, if any existed, of continuing the communication by water from the end of the old canal to the waters of the Ohio River.

These gentlemen have devoted all their energies to the work, keeping the field until the last moment, and collecting a large mass of most valuable information. They of course made free use of the reports and surveys of their able predecessors in the investigation of the subject before them.

It has been considered desirable to sum up at once the results of the survey of 1870.

The reports of Messrs. Hutton and Turpin are accordingly transmitted herewith. I refer for details to them.

The "Central Water-line," as it is commonly called, is a project contemplating the completion of a continuous line of water communication from the waters of the Ohio River, at the mouth of the Kanawha, to the waters of Chesapeake Bay and the Atlantic, at the mouth of James River, in Virginia. The necessity for some such line as this, as a means of cheap and certain commercial intercourse between the great producing regions of the West and the Atlantic coast, has long been advocated and urged upon public attention by various persons and parties of ability and influence. That there now exists no direct line of water communication between the Mississippi basin and the sea-board is an undeniable fact; and it is equally true, that of the two circuitous and indirect routes now in use, the northern is subject to interruption by ice, and the southern to a degree of heat highly prejudicial to the preservation of the staple articles of transportation.

The general position of the route for this desired communication seems to have been approximately located by common consent since the first inception of the idea, constantly modified, however, in detail, both as to location and mode of transportation, as the wealth and requirements of the two sections increased. The original idea contemplated simply a navigation in batteaus of the rivers on the east and west of the Alleghanies, and the passage of the mountains by a turnpike road.

The requirements of to-day demand a canal of large size, and a navigation for vessels of several hundred tons burden.

The location referred to for this line commencing at Richmond, (the head of open navigation on the James River,) follows the valley of that stream and its head tributaries, to the base of the Alleghany mountains; thence passing through or over them, it descends the headwaters of the Greenbrier, New, and Kanawha rivers, and down the latter to the Ohio.

The first surveys for this route were made in 1817–'19, contemplating a slack-water navigation for batteaus of 2 or 3 feet draught, and a portage over the mountains. The next were made in 1826–'28 by Captain McNeil, United States Topographical Engineers, for a canal and slack-water navigation, passing the mountains by a tunnel 2.6 miles long, at an elevation of 1,916 feet above tide. Subsequent surveys and examinations were made at various times by engineers of ability and reputation, but the general plans and locations of McNeil remained unchanged.

As early as 1785, a company was organized for the improvement of the James River, and some efforts were made toward effecting a betterment of the navigation of that stream. In 1832 the James River and Kanawha Company was incorporated, and the rights and duties of the old company were transferred to the new. In 1836 they commenced the construction of a canal, having in view the connection of the waters of the James and the Ohio Rivers.

Their line, as located and partially constructed, commences at Richmond, with a large dock and tide-water connections; extending thence up the valley of the James River through Lynchburgh to Buchan distance of one hundred and ninety-six and one-half miles, inclu one hundred and fifty-nine and three-fourth miles of canal, and th six and three-fourth miles of slack-water navigation, which is now co pleted and in working order. Thence it follows up the valleys of Ja and Jackson Rivers to Covington, on the latter stream, a distance of fo seven miles, of which 41 miles is canal, and six miles is slack-water na igation. This portion has been located, and its execution was co for, but it is not as yet entirely completed.

From Covington, the line as projected to the Greenbrier River three and one-third miles distant, on the western slope of the mo ains) crossed Jackson River as a canal, and ascending Dunlop's Cr at the base of the Alleghanies, followed Fork Run to the summit where it pierced the mountains by a tunnel 2.6 miles long, at an el tion of 1,916 feet above tide. It descended thence the valleys of hoe and Howard's Creek by canal to the Greenbrier and New Ri down which, as well as down the Kanawha, slack-water navigation projected to the Ohio, a distance of two hundred miles, making a distance from Richmond of 486.13 miles.

The large number of locks required to attain this summit-lev the consequent consumption of time in transit by this route. examinations to be made with a view to finding a better. In E. Lorraine, the engineer of the James River and Kanawha Co advised the adoption of a new location, which, by the use of a nine miles in length, reduced the elevation of the summit-level dred and sixteen feet, thus making it but one thousand seven feet above tide. This change saved three and one-half miles length of canal, and forty and one-half miles of *equated length*, ing the saving of time in lockages, and cost of working and repair

The operations during the last season were confined to a sur this tunnel line and its approaches, and to such examinations routes westward from that point as the time and money at com would permit. The results have been to determine definitely the and extent of the tunnel for passing the mountains; the facilities difficulties to be expected in its execution; and to enable an ap mate estimate to be made of the money and time required to co the tunnel and its connections between the mouth of Fork Run of the company's definite location) and the mouth of the Kanawha

The canal, as already constructed, has a width at water-line of and a depth originally of 5 feet. As these dimensions would pro limited for the new and extended line, surveys were also made son, with a view to its enlargement to the dimensions proposed extension westward from mouth of Fork Run, viz, 70 feet w water-line, with a depth of 7 feet, the enlarged locks to be 120 f tween the gates, and with twenty feet width of chamber.

The line which I have now to recommend commences at m Fork Run, ascends that stream by a canal of the dimensions just with six blocks of 12 feet lift each, to the summit-level, at 1,7 above tide. It then pierces the main range, passing under and Kate's Mountains, by a tunnel 7.8 miles long, with a section by 34½ feet, being 46 feet wide at water-line, and 7 feet deep. It into the valley of Howard's Creek, which it descends to the Gr by three locks of 10-feet lift each.

From this point the canal ceases, (except in two cases where tions occur,) and a continuous slack-water navigation is proj Greenbrier to New River, and down New River to Ly ighty-five miles above its mouth. To eff require 55 dams, varying in height from 12 to 40 feet, and in length from 200 to 600 feet. These are proposed to be built of masonry and provided with locks, &c., of suitable size and dimensions to pass vessels from one pool to another. From Lyken's Shoals to the mouth of the Kanawha, open navigation is proposed, the fall throughout the length being equalized by low dams at regular intervals, having sluices to permit the passage of vessels.

The estimates for this work (given below) contemplate the construction of the whole in a substantial manner, proportionate to its importance and the gravity of the results which would attend any stoppage of its use caused by failures in its mechanical structures.

From mouth Fork Run to Greenbrier, at mouth Howard's Creek, exclusive of tunnel	$2,383,447
Tunnel	13,253,310
Down Greenbrier and New River	13,243,541
Down Kanawha River eighty-five miles	973,900
Ten per cent. contingencies	2,986,420
	32,840,618
From Richmond to Fork Run	14,781,644
	47,622,262

The idea of connecting the waters of the Atlantic slope and the Mississippi valley, by joining the headwaters of the James and Ohio rivers, has long been entertained by distinguished men. It is certainly a very attractive project, from its simplicity and from the grandeur of its results, both in a physical and commercial point of view. It is far older than railroads, and so the use of the canal, as the means of connection, was proposed. When the railroad was introduced, public attention was turned in that direction, to the exclusion of the canal, although still in this case the intention was simply to have the railroad a short link between the headwaters of the James and the Kanawha. This railroad is building and extending beyond the limits of its first design, so as to become soon one of the great competing lines ot communication of this kind between the East and the West.

Notwithstanding the immense increase of facilities for transportation, which have been created in the past twenty or thirty years, the Great West and the Northwest have overrun them in their exuberant productive capacity, and after testing all other routes by rail and existing canals and lakes and rivers across the continent, and by river and gulf to the Atlantic, are calling loudly for the construction of a great, cheap, short, national highway, to carry to market their surplus products; this voice must be heard and heeded.

The national character of this work is demonstrated by the statement just made. If a river existed along the whole extent of the proposed route of the water-line, it would unquestionably receive from the General Government such improvement as it needed. This connection belongs to the same class of works as the Louisville and Portland Canal on the Ohio River and the improvement of the Des Moines and Rock Island Rapids on the Mississippi.

As our great and growing country expands, in accordance with its magnificent and manifest destiny, toward the north and toward the south, and its extremities become more remote from each other, it will be well to have some great national work in the geographical center, a tracting thither public attention and interest and capital, and consetunnel, not only without apprehension of fai ing of assured certainty of success. It is no long but an ordinary undertaking. The Lorraine tun tion derived from the survey of 1870, will be 7.8 n length of the Mont Cenis tunnel is seven and on the Hoosac being four and three-fourths miles. from the circumstances of its position, will take a execution than the Mont Cenis and Hoosac tunnels, either of them. See especially the remarks of Mr. ject, as well as of Mr. Lorraine and of Mr. Latrobe.

It is needless for me to refer to the engineering work, which are sufficiently discussed for present pu of Mr. Hutton and Mr. Turpin, and in the able pa Neither is it necessary, perhaps it would not be pro in detail the arguments which have been so elab many able minds as to the commercial advantages o (See several of the attached papers.)

It has been supposed by some that the day of ca do not sustain this view. There is no doubt that ger travel, and many kinds of freight, the railroad ferred as the means of transportation, and the bus falling to the railroads is enough to pay handsom value. But there is no question that when the circ that slowness of movement is permissible, and th moved large, the cheapness of the canal becomes o who chooses to consider the statistics of the case. even when the canals have been used simply as a pa of political parties. If managed with honesty and fo they were intended, their ability to carry freight railroads is beyond dispute. It is unquestionable t has been, is now, and will continue to be, a most val erty to the State of New York, notwithstanding the ment of competing railroad lines. Its contemplate the best proof that can be given of that statement

A great means of intercommunication like the central water-line, which will, by cheapening the cost of their delivery, cheapen the cost to consumers of the important articles of food and fuel, which are necessaries of life for all, both rich and poor, while not diminishing but increasing the receipts of producers, becomes an object of the greatest interest to the nation.

By cheapening the cost of delivery of many of the chief articles of export, at the great commercial cities of the Atlantic, it facilitates our competition in foreign markets, and assists in giving us the balance of trade, and becomes in this view also a most interesting object from a national stand-point, and well worthy of the attention and assistance of the National Government.

Some interesting extracts are introduced below, taken from a speech of the Hon. W. Lawrence, of Ohio, delivered in the House of Representatives May 23, 1870. The object of the speech was to demonstrate the necessity for the provision of additional means of transportation for the products of the Northwest, and to show the greater cheapness of transportation by water over that by rail.

The ultimate object of the speech was to induce congressional action in the direction of gaining free access to the ocean for western products by the way of the Canadian canals and the St. Lawrence River.

His arguments as to the necessity for additional means of exit to the ocean, and as to the greater cheapness of a water-route over the railroad, apply equally to the central water-line and to the line whose adoption he was advocating; but the central water-line has the great advantages of shortness, comparative non-interruption by ice, and freedom from the dangers of the navigation of the lakes and St. Lawrence River, and of being in the heart of our own country.

Extracts from the speech of Hon. W. Lawrence, of Ohio, in the House of Representatives, May 23, 1870.

* * * * * * *

But in regulating trade on this continent, as well as with the nations of Europe and Asia, we should not overlook the great interests of the producing and laboring portions of our citizens.

* * * * * * *

GRAIN-PRODUCING STATES.

The great grain-producing States of the central West are Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, and Iowa, with a population of probably eleven millions.

* * * * * * *

The grain product of the United States, including wheat, corn, rye, oats, &c., in the year 1865, was 1,343,027,868 bushels, valued at $1,118,904,376. Of this, the product of wheat was 151,999,906, and of corn 867,946,295 bushels.

The wheat product of 1868 was 224,000,000 bushels, of which 32,000,000 were used for seed, 164,000,000 consumed in the United States, and 28,000,000 exported. The population, product, amount consumed, and surplus, were, in the States bordering on the lakes, as follows:

States.	Estimated population in 1868.	Bushels wheat raised in 1868.	Consumed.	Surplus.
Ohio	2, 955, 673	17, 050, 000	14, 117, 000	2, 933, 000
Indiana	1, 804, 985	17, 366, 000	9, 933, 000	7, 433, 000
Michigan	1, 128, 513	16, 612, 000	7, 132, 000	8, 880, 000
Illinois	2, 519, 268	28, 560, 000	13, 630, 000	14, 930, 000
Wisconsin	1, 011, 082	22, 660, 000	7, 434, 000	15, 226, 000
Minnesota	382, 465	14, 500, 000	3, 349, 000	11, 151, 000
Iowa	1, 021, 260	20, 300, 000	6, 875, 000	13, 425, 000
Kansas	256, 650	1, 537, 000	1, 279, 000	258, 000
Total	11, 079, 896	137, 985, 000	63, 749, 000	74, 236, 000

* * * * * *

PRICES—HOW DETERMINED.

The amount which a western farmer realizes for a bushel of wheat depends on two circumstances, the price in the controlling market and the cost of transporting it there.

Though England buys but a small part of our wheat product, yet she consumes the largest part of our wheat export, and the Liverpool wheat market controls the price in New York, Toledo, and Chicago, very much as the price of our national bonds at Amsterdam and Threadneedle street determine the price in the United States, or as Wall street determines the price of gold at Cincinnati. The gentleman from Missouri (Mr. Asper) has shown this in his speech of March 30, by quotations from the New York Journal of Commerce of March 22.

The price of wheat, then, in Liverpool has an effect upon the whole wheat product of our country far beyond the export demand. With this, then, as the initial point in fixing prices, it requires no argument to prove that the cost of carrying wheat from the place where it is produced to Liverpool will be deducted from the Liverpool price, and the producing farmer will receive only the residue.

Dr. William Elder, until recently in the Treasury Department, recognizing this fact, in a pamphlet just issued in favor of a protective tariff, says:

Putting a bushel of red winter wheat at $1 30, (nine shillings per one hundred pounds,) its price in Liverpool on Christmas Eve, 1869, we find its value in gold to the western farmer by the following deduction:

Carriage from Chicago to New York	30 cents.
Marine freight	16 cents.
Marine insurance	2¼ cents.
Commission	3 cents.
Handling	2 cents.
Charges from Chicago to Liverpool	53¼ cents.

To this must be added the expense of placing it in Chicago, (from place where produced:)

	Currency.
Storage and commission	5 cents.
Insurance and loss	½ cent.
Carriage to Chicago	10 cents.
Handling	3 cents.
	18½ cents,

equal in gold to 15½ cents.

Total deduction from price in Liverpool, 69 cents. Leaving to the farmer 61 cents in gold—73 cents currency—per bushel.

FREIGHT AND DEALER'S PROFITS—MODE OF TRANSPORTATION.

The secretary of the Chicago Board of Trade has furnished to the Bureau of Statistics a table showing that during the winter months, in the absence of canal and lake competition, railroad freight from Chicago to New York reaches nearly thirty cents a bushel for wheat.

* * * * * * *

The great cost of constructing and operating railroads is such that they cannot compete with canal, lake, river, or ocean transportation for heavy freight. In a report made by Hon. Israel T. Hatch to the Secretary of the Treasury, in January, 1867, he says, in House Executive Document No. 78, second session Thirty-ninth Congress, page 4:

"An elaborate investigation shows the following results as exemplified by a fair comparison of the relative cost of transportation by rail and the other means of conveyance best known in the United States:

"By rail costs 733.3 per cent. greater than ocean transportation; by rail costs 525 per cent. greater than over great lakes; by rail costs 215 per cent. greater than Erie Canal, (enlarged;) by rail costs 400 per cent. greater than over Hudson River."

But the western producer is liable to suffer, not merely by reason of the necessarily great cost of railroad transportation, but by extortionate charges rendered practicable by the monopoly of the recent immense railroad combinations and by the want of adequate rival and competing routes and modes of transportation.

With railroad freight costing about 30 cents to transport a bushel of wheat from Chicago to New York, besides other charges, by far too large a share of the product is taken from the farmer, and he needs cheaper transportation.

Will it be said the lakes, the Erie Canal, and the Hudson to New York do or will furnish all that is necessary?

* * * * * * *

The annual tax now imposed upon the people of the West—these enormous charges for tolls and freight, profits of dealers, all deducted from the final market price of products, reducing the amount the producers receive—ought not to be longer endured if it be practicable to avoid it.

* * * * * * *

Freights can be reduced, and thus, even without any increase in the price of wheat at its ultimate market, give to the producer more of that price than he now receives.

* * * * * * *

The gentleman from New York (Mr. Bennett) has told us that "in 1836 the surplus breadstuffs exported by the lake and the Erie Canal were altogether 1,239,351 bushels, including flour estimated as wheat. In 1860 the movement eastward by every avenue—by canal, by railroad, and by the St. Lawrence River—had attained the magnitude of 78,652,486 bushels, and in 1862 its enormous aggregate was 137,667,870."

And referring to Ohio, Indiana, Illinois, Michigan, Wisconsin, Iowa, and Minnesota, he says:

"In 1840 the cereal products of these States amounted to 267,265,877 bushels; in 1850 they had increased to 434,862,661 bushels; in 1860 to 670,031,559 bushels; and in 1870 we shall probably find them aggregating about a thousand million bushels."

A considerable portion of all this increasing product must find an eastern market, and to all this must be added lumber, wool, and other products of western soil, mines, forests, workshops, and factories.

The export of Indian corn to foreign countries in 1868 was 11,147,490 bushels, valued at $13,094,036, and 336,508 barrels of Indian meal, of the value of $2,068,430.

With the rapid growth of western products for export, more and greater routes of transportation must speedily be opened up. Already we have a memorial asking the aid of Congress for a ship-canal between the lakes and the Mississippi, by way of Wisconsin and Fox Rivers, and the country is discussing the project of a "central water-line from the Ohio River to the Virginia capes, connecting the Kanawha and James rivers," one of the publications in advocacy of which says:

"Cheap transportation is the great necessity of the West. Its products exceed in amount the means at command of cheap outlet to the sea-board, and millions of western producers are placed under the power of carriers."

* * * * * * *

The gentleman from New York (Mr. Bennett) estimates that the reduction on freights by the enlargement of the locks of the Erie Canal "would equal a saving of $15,000,000 per annum on the present movement of grain eastward by the water routes." On the eastward movement of other articles it would be a very large sum. On the westward movement of articles, the cost of which would be reduced to western consumers, the saving would be a vast sum also.

* * * * * * *

In illustration of these views I present some statistical tables alike interesting and valuable:

[From report of Chicago Board of Trade.]

LAKE (STEAM) AND RAIL FREIGHTS.

Weekly rates of freight by propeller to Buffalo, and thence by rail to New York, for the season of lake navigation in 1869.

Week ending—	TO NEW YORK.		
	Flour, per bbl.	Provisions and fourth class per 100 pounds.	Grain, per 100 pounds.
April 24	$0 85	$0 42½	$0 42½
May 1	85	42½	42½
May 8	85	42½	42½ to 45
May 15	85	42½	45
May 22	80 to 85	40½	37½ to 45
May 20	80	40½	37½ to 39
June 5	80 to 85	40 to 42½	37½ to 39
June 12	85	42½	40 to 42½
June 19	85	42½	42 to 42½
June 26	75 to 85	37½ to 42½	37½ to 42
July 3	75	37½	37½
July 10	75 to 80	37½ to 40	37½ to 40½
July 17	75	37½ to 40	37½
July 24	75	37½	37½
July 31	65 to 75	32½ to 37½	35 to 37½
August 7	65	32½	35
August 14	55 to 65	27½ to 32½	30 to 35
August 21	50 to 75	25 to 37½	30 to 37½
August 28	50 to 75	37½	35 to 37½
September 4	50 to 75	37½	35
September 11	50 to 75	37½	35 to 37½
September 18	50 to 75	37½	37½ to 40
September 25	50 to 75	37½	37½ to 40
October 2	50 to 75	37½	37½
October 9	50 to 75	37½	37 to 40½
October 16	75 to 85	37½ to 42½	42 to 50
October 23	85 to 95	42½ to 47½	50
October 30	95 to 1 10	55	50 to 55
November 6	1 10	55	55 to 60
November 13	1 10 to 1 15	55½ to 57½	60
November 20	1 15	57½	60 to 62½
November 27	1 15	57½	62½

Statement of all rail freights from Chicago, eastward, during the year 1869.

Date.	TO NEW YORK.					TO BOSTON.					TO PORTLAND.					TO BUFFALO AND SUSPENSION BRIDGE.					TO PHILADELPHIA AND BALTIMORE.				
	Flour, per barrel.	Grain, per 100 lbs.	Fourth-class freight, per 100 pounds.	Bulk meat, per 100 pounds.	Dressed hogs, per 100 pounds.	Flour, per barrel.	Grain, per 100 lbs.	Fourth class freight, per 100 pounds.	Bulk meat, per 100 pounds.	Dressed hogs, per 100 pounds.	Flour, per barrel.	Grain, per 100 lbs.	Fourth-class freight, per 100 pounds.	Bulk meat, per 100 pounds.	Dressed hogs, per 100 pounds.	Flour, per barrel.	Grain, per 100 lbs.	Fourth-class freight, per 100 pounds.	Bulk meat, per 100 pounds.	Dressed hogs, per 100 pounds.	Flour, per barrel.	Grain, per 100 lbs.	Fourth-class freight, per 100 pounds.	Bulk meat, per 100 pounds.	Dressed hogs, per 100 pounds.
		Cts.	*Cts.*	*Cts.*			*Cts.*	*Cts.*	*Cts.*			*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	*Cts.*	*Cts.*		*Cts.*	*Cts.*	*Cts.*	
January 1 to January 25	$1 50	80	75	90	$1 10	$1 60	85	80	95	$1 20	$1 60	85	80	90	$1 20	80	40	40	50	60	$1 40	70	70	80	$1 00
January 25 to February 1	1 40	75	70	85	1 10	1 57	85	75	90	1 20	1 50	85	75	85	1 20	70	40	35	42½	60	1 30	65	65	80	1 00
February 1 to February 9	1 20	65	60	75	1 10	1 30	70	65	80	1 20	1 30	70	65	75	1 20	65	37½	32½	40	60	1 30	65	65	80	1 00
February 9 to February 17	1 10	60	55	70	1 10	1 20	65	60	75	1 20	1 10	60	55	70	90	65	32½	32½	40	60	1 10	55	55	70	1 00
February 17 to March 2	1 00	50	50	65	80	1 10	55	55	70	90	1 10	60	55	70	90	65	32½	32½	40	60	1 10	55	55	70	1 00
March 2 to March 11	90	50	45	60	80	1 10	55	55	70	90	1 00	60	50	70	90	65	32½	32½	40	60	1 10	55	55	70	1 00
March 11 to April 12	90	50	45	60	80	1 10	55	55	70	90	1 00	60	50	70	90	65	32½	32½	40	60	90	45	45	60	70
April 12 to June 12	1 00	50	50	65	......	1 10	60	55	70	......	1 00	50	50	65	......	65	32½	32½	......	......	90	45	45	60	......
June 12 to September 21	90	45	45	60	......	1 10	55	55	70	......	1 00	50	50	65	......	65	32½	32½	......	......	90	45	45	60	......
September 21 to October 11	90	45	45	60	......	1 10	60	55	70	......	1 00	50	50	65	......	65	32½	32½	......	......	90	45	45	55	......
October 11 to October 18	1 10	55	55	70	......	1 20	65	60	75	......	1 20	65	60	70	......	70	35	35	......	......	1 00	50	50	60	......
October 18 to October 27	1 20	65	60	70	1 10	1 30	70	65	80	1 20	1 50	80	75	80	1 20	70	35	37½	40	60	1 10	55	55	65	......
October 27 to November 23	1 30	70	65	75	1 10	1 40	75	70	80	1 20	1 50	80	75	80	1 20	70	35	35	40	60	1 10	60	55	65	1 00
November 23 to December 31	1 30	70	65	75	1 10	1 40	75	70	80	1 20	1 40	75	70	80	1 20	70	35	35	40	60	1 20	65	60	50	1 00

Information furnished by the secretary of Board of Trade. Chicago, Illinois.

EDWARD YOUNG,
In Charge of Bureau of Statistics.

Should it be decided by the national authorities to proceed with this work, additional surveys will be necessary for the definitive determination of the location in detail. These surveys should be immediately undertaken, and a sum not less than $25,000 should be appropriated for them.

The following papers accompany this report:

1. Report of Mr. W. G. Turpin, dated December 28, 1870.
2. Report of Mr. Wm. R. Hutton, dated January 21, 1871.
3. Printed pamphlet on "Central Water-line," 1869, in duplicate, containing the interesting and instructive paper of Mr. E. Lorraine, the chief engineer of the James River and Kanawha Company. This paper contains an important letter from Mr. B. H. Latrobe, whose known ability and experience entitle his opinions about the long tunnel to the greatest weight. Mr. Lorraine's paper is prefaced by a very forcible argument to show the necessity of a central line of navigation directly eastward, from the Ohio River to the Chesapeake Bay.
4. Memorial (printed in duplicate, 1870) of the general assembly of Virginia to the Congress of the United States.
5. Printed report of the committee of National Board of Trade on the continuous water-line, in duplicate, 1869.
6. Printed remarks of T. M. Monroe, of Dubuque, before the National Board of Trade in December, 1868.
7. Printed memorial of delegates to the National Board of Trade, 1870, Cincinnati. In duplicate.
8. Printed report on physical survey of Virginia, by W. F. Maury, 1869.
9. Letter, printed, of Mr. Joseph Segar on the "Great thoroughfares and their national aspects," October 1, 1868.
10. Extract from letter of Mr. E. Lorraine, dated November 28, 1870.

Respectfully submitted.

WM. P. CRAIGHILL,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Q 13, (2.)

BALTIMORE, MARYLAND, *January* 21, 1871.

SIR: I have the honor to submit the following preliminary report on the results of the examinations and surveys for the extension of the James River and Kanawha Canal, from the eastern base of the Alleghanies; together with an approximate estimate of the cost of the improvement.

The necessity imposed upon me by you to make report early in the present year, to enable Congress to take action upon the matter, has not allowed time for much careful preparation or detailed study; but no point of importance has been overlooked, and the estimate is believed to be sufficient to cover the cost.

The work was placed by you in my hands about the middle of August last, with instructions to determine "the best route for the canal itself, and the means of its ultimate connection with the Ohio River, so as to open a great central line of water communication for the West and Northwest with the East." The organization of a corps of assistants was immediately commenced, and by the 24th of August they were in the field.

The length of line covered by these instructions was two hundred and twenty-two miles. The amount appropriated to it being hardly sufficient to organize one party, it was evident that but a small portion of it could be actually surveyed. The late period of the season, as well as the smallness of the appropriation, rendered it necessary to make use of all available information from reliable sources, and to limit our own operations in the field to such points as had not been satisfactorily determined before.

With a view, therefore, first to decide as to the best crossing of the main Alleghany mountain, the survey was commenced at the mouth of Fork Run on Dunlap's creek, at the termination of the definitive location heretofore made for its works by the James River and Kanawha Company, and a line was thence traced to the Greenbrier River near the mouth of Howard's Creek.

These mountain surveys occupied more than a month, and it was not until the 6th of October that we were able to begin the examination and survey of the Greenbrier. This stream presented no difficulties of a formidable nature, while those at New River had been represented as "appalling" and "insurmountable."

Leaving, therefore, my assistants to continue the survey of the former stream, I made a personal reconnaissance of New River as far as Bowyer's Ferry, resulting in the abandonment of the Greenbrier survey and the transfer of the party to New River.

A fresh line was commenced just below Stretcher's Neck, (the level heights being kindly furnished by the engineers of the Chesapeake and Ohio Railroad,) and prosecuted until the 20th of November, when the low state of the funds rendered it necessary to disband the party at a point some three miles below Bowyer's Ferry. The remainder of the line was gone over by myself as far as the mouth of the Kanawha River.

OBJECT OF THE EXTENSION.

The enlargement and extension of the James River and Kanawha Canal, which is known to our commercial conventions and others by the title of "the Virginia Water-line," is designed to connect the Ohio with the Atlantic, through the valleys of the Kanawha and the James and their tributaries, and to form an interior water-line for the transportation at low rates of heavy freight, from all parts of the West to the Atlantic, combining river, canal, and slack-water navigation.

The project looks to the enlargement of the present James River Canal, already completed to Buchanan, one hundred and ninety-one miles from Richmond, its continuation to and across the Alleghany summit to the Greenbrier River, and by the improvement of that and New River to the Ohio.

From Hampton Roads to Richmond, a distance of one hundred miles, the James River is navigable for vessels of one thousand tons. Thence to the Greenbrier River, the length of the proposed canal is 274.1 miles. The total length of Greenbrier and New Rivers to the foot of Lyken's shoals on the Kanawha 124.2, and thence to the Ohio, 85.1 miles; making the total distance from Hampton Roads to Mount Pleasant on the Ohio River, 609.7 miles.

SCALE.

The scale of the enlargement was not specified by the law making the appropriation, or in the formal instructions communicated to me.

between the gates and 20 feet wide at the lower wat portions are taken, chiefly, because they are the b been written upon the subject, and particularly of t largement from Richmond to Fork Run.

Cheapness of transportation is the great object to work under consideration, and this varies very nearl of the boats used. A smaller canal could be built the cost of transportation on it, and of management, higher. I consider the dimensions adopted as the l erly carry out the objects in view.

On the other hand, any considerable enlargement o the cost in a rapidly ascending ratio; the water-sup more uncertain or expensive, and, in view of the cap ment of the locks proposed, any material change s rable. Were the question entirely new, however, somewhat wider lock on the canal, as tending to chea and offering better facilities for future enlargement.

PREVIOUS SURVEYS.

In 1817–'19 surveys were made of Greenbrier an Messrs. Moore and Briggs, with a view to their impr for batteaux drawing from 1½ to 2 feet of water onl valuable for the accurate description of the rivers, th

From Dunlap's Creek to the Greenbrier River full surveys for a canal were made in 1826–'28 by Captai States Army, every route being examined which g resulting in a location by way of Fork Run and How was adopted by the James River and Kanawha Comp surveys by the engineers of the company have confirm of this location.

In 1838 Ed. H. Gill made a minute and careful sur the improvement of the Kanawha River, under the di Ellet, jr., then chief engineer, recommending a system to pool, combined with wing-dams, for the purpose of of 31 feet at low stages

Another survey and estimate for improving the Kanawha was made, under the direction of Mr. Fisk, in 1855, by John A. Byers, on the plan of sluice-dams, at short intervals, on the ripples, with a view to obtain 5 feet depth of water.

A third project was submitted to the directors of the Kanawha improvement, in 1860, by Charles Ellet, jr., their engineer at that time, who proposed, after clearing out the sluices and confining the water to the channel, to supply from reservoirs the quantity needed for purposes of navigation beyond the natural flow of the stream.

LOCATION ACROSS THE ALLEGHANY SUMMIT.

The first point in my instructions was to determine the best route for the canal from the termination of the definitive location made. As before stated, the line selected by Captain McNeil in 1828 had been adopted as the best that could be found. Other routes have been brought forward by local advocates, none more prominently than that by way of Craig's Creek, connecting it with Sinking or Poverty Creeks, (more southern branches of New River.) This line was examined by Captain McNeil, and more recently by other engineers, all of whom have declared it to possess no claims to attention. Under the circumstances, and in view of the little time at my disposal, I have made no further investigations into the merits of this route.

While the line adopted by Captain McNeil has not been improved as to its general location, an important modification of it has been recommended and urged by Mr. Ed. Lorraine, chief engineer of the James River Company. McNeil's line ascended the valley of Fork Run to an elevation of 1,916 feet above tide, and there pierced the ridge with a tunnel of two and five-eighths miles in length, whence it descended the valley of Howard's Creek to the Greenbrier. Mr. Lorraine proposes "to establish the summit at a level 1,700 feet above tide, or twenty feet above the level of Greenbrier River, at the mouth of Howard's Creek, and pass through the Alleghany Mountain by a tunnel about nine miles long." This, then, was the real question as to the route across the Alleghany summit.

The line now recommended for the canal, from the mouth of Fork Run, ascends the valley of that stream to an elevation of 1,700 feet above tide, then passes through the Alleghany Mountain by a tunnel 7.8 miles in length, crossing also under the summits of Tuckahoe and Kate's Mountain, and, emerging in the valley of Howard's Creek, follows it to the Greenbrier River. The whole distance is 12.6 miles. The ascent on the eastern slope is 72 feet, overcome by six locks of 12 feet lift, and the descent westerly from the summit-level, which is 10.55 miles in length, is by three locks of 10 feet lift to the river.

The supply of water will be taken from the Greenbrier River; but as this does not at all times furnish a sufficient quantity, recourse must be had to reservoirs to meet the deficiency. These may be constructed on the river itself, but the very competent surveys made by Mr. Lorraine for a reservoir on Anthony's Creek, one of its tributaries, show that site to be a desirable one, both as to cost and efficiency.

The alternate route for the passage of the main divide continues up Fork Run to an elevation 216 feet above the first-described line; the tunnel is two and five-eighths miles long, and the whole number of locks, ascending and descending, is forty-six.

The tunnel on this route can be worked with any desired number of shafts, and lying principally in the slate and shaly sandstones, the estimate has been made to cover the cost of arching the whole tunnel.

and 34½ feet high, the water-way being 7 by 46 feet, 6 feet and semicircular roof. I have no doubt that will be used as the motive power in this tunnel, b necessary to provide a narrow tow-path, rather as a of accident, than as an auxiliary to navigation. This extended through the rock-cuttings of the approach which also the width at water-surface is somewhat re ing an equal section.

The extreme length of tunnel is 40,380 feet, and diminishing the depth of shafts, has been located upo thirty miles radius, although in construction the tun straight from shaft to shaft. The shafts vary in de feet, and the greatest distance between any two of t

The cost of the tunnel varies with its width. Bei it must afford room for the passage of loaded boats directions, and, for the same reason, the resistances are directly dependent on the width of water-way largely increased.

The dimensions given allow 6 feet for guard-tim between passing boats, and the resistances will be greater than on the 70-foot canal.

The rock through which the excavation will be sandstone, of variable quality, from a sandstone sha character of rock. Lying below the summit crossed a to 1,300 feet, it is reasonable to suppose that a large will be sufficiently firm and solid to stand without a li however, included in the estimate the cost of archi whole length of the tunnel.

The cost, as estimated, of this line from the mou
Fork Run to the Greenbrier is ....
And by the high-level route.......................

Difference against the low level...... ....

Before comparing these two routes as to the rel

The actual excess in length of the high-level route is about three and one-half miles; the whole amount of lockage is 432 feet. This being equated by the rule deduced from observations on the Erie, is equal to thirty-seven miles of level canal, making the equivalent difference in length equal to forty and one-half miles of level canal.

The cost of transportation on canals of these dimensions is stated by McAlpine, in his report of 1854, to be four mills per ton per mile. The officers of the Erie have found it to vary from 2.16 to 2.25 mills per ton per mile up to 1866, and in 1868 to have reached 4.6 mills. I make the cost on present work, reduced to a level, 2.3 mills. Applying then this price we have 9,720,000 tons by 40½ mills by $2\frac{3}{10}$ mills=$905,418.

Which, at 7 per cent., is the interest on	$12,934,542
We have seen the excess of cost of the low level over the higher route to be	7,677,193
But this result shows that the actual saving in cost of transportation by the lower line represents a capital of	5,257,349

On the flat ground adjacent to the river it is proposed to construct a basin, in which cargoes can be transferred from the large barges navigating the rivers to those proper for use in the canal.

WATER-SUPPLY.

We have assumed a trade of 180 boats per day, but it will be prudent to provide a supply of water for 200. Allowing them one and one-half locks full of water to each boat passing the summit level, we will require three hundred locks full of water per day for a maximum trade. The greatest lift between Greenbrier and Covington, the portion of the line to be supplied from the summit level, is 14 feet, and the locks being 120 feet by 20, we have 300 locks by 120 by 20 by 14, equal to cubic feet, per day, 10,080,000.

Evaporation on 21.9 miles, (the tunnel being excluded,) ⅓ inch per mile per day, cubic feet	225,264
Filtration, cubic feet	5,240,400
Waste at structures, cubic feet	43,200
Leakage at lock gates, cubic feet	1,728,000
Total	17,316,864
The minimum flow of the Greenbrier, as gauged by Captain McNeil, was 97 feet per second, or per day	8,380,800
Leaving to be supplied from other sources	8,936,064
Suppose the flow of the Greenbrier to continue at its minimum for an average period of 120 days, the total quantity to be furnished would be, cubic feet	1,072,327,680
The reservoir surveyed by Mr. Lorraine will contain 4,806,000,000 cubic feet, and the observed discharge of the stream (which has been gauged) for a year of much less than the average rain-fall is	5,484,229,000
Diminish this by the evaporation of ¼ of an inch per day for one year from the surface of the reservoir	899,405,100
And we have available for the canal	4,584,823,900
Or a surplus of	3,512,496,220

As fears have been expressed by some persons not familiar with the subject, that a reservoir supplied chiefly from rain-fall might fail to furnish the anticipated supply, it is well to observe that the valley of the Greenbrier River is extremely favorable for the construction of reservoirs, with which it might be filled throughout its length of sixty miles; in which any desired amount of water from the spring and winter floods might be stored up for use in time of drought.

At the mouth of Howard's Creek the canal, having passed the Alleghany summit, is terminated. The means of its ultimate connection with the Ohio is next to be considered. The valley of the Greenbrier River is narrow, limited on one or both sides by steep bluffs or cliffs. The flat land is small in quantity, and in no place continues for any considerable distance.

The improvement recommended by Mr. Gill, partly canal and partly slackwater, would be the more economical for a work of the dimensions proposed by him, but the larger canal now under consideration would not find room in many places along the river bluffs without too serious a reduction of the water-way of the river itself. I therefore recommend a continuous slackwater, (broken at two points only by short sections of canal,) which would be extended to the mouth of the river by nineteen dams of heights varying from 10 to 35 feet. At Alderson's, and again a short distance below the falls of Greenbrier, short canals of large dimensions are introduced to avoid very expensive locations for dams, which would otherwise be required. The length of the river is 49.086 miles, and the total fall 316 feet. New River is, particularly in its lower portions, of a different character, the banks being composed almost entirely of boulders, among or over which the construction of a canal presents formidable difficulties. These, however, are not in the way of a slackwater improvement, as is now recommended. The river and its valley are remarkably favorable for a work of this character, except in one single particular, and that is the difficulty (on a hurried reconnaissance) of determining rock sites for dams. The river is in many places filled with boulders of every size, sometimes immensely large, and it is not possible, generally, to estimate their depths. At such points the cost of foundations cannot be determined in advance. I have therefore deemed it necessary to locate dams at those places only where the ledge-rock can be discovered. In consequence, some of them are higher than I could have wished, and the estimate proportionately greater. It is probable that better sites will be found by a more detailed survey, and that the cost will thereby be reduced. Indeed, I expect a thorough survey greatly to diminish the estimate. It was not possible, in the time and with the force at my disposal, to undertake an examination in detail of the pools and shoals, with a view to make a final location. A height was therefore taken for each dam sufficient to raise the water 7 feet at the foot of the one next above, without regard to its present depth.

The length of New River from the mouth of Greenbrier is 67.433 miles: the fall in this distance, 756 feet.

The upper portion of the Kanawha from the mouth of Gauley River to the foot of Lyken's Shoals requires the same kind of improvement as the Greenbrier and New Rivers; the fall being too great for any open navigation, its cost is included with those rivers.

The whole number of dams required is 55, varying from 12 to 41 feet in height, and in length from 200 to 600 feet.

They are to be constructed of heavy rubble masonry, laid in hydraulic cement, and covered on top with timber and plank.

DIMENSIONS AND PLAN OF SLACK-WATER.

The locks are designed to be 200 feet in length between the gates, and 40 feet in width at the lower water-line, with 7 feet depth of water. These dimensions will admit a barge of 700 tons, or two canal boats for the enlarged canal. The locks as well as the dams are to be constructed of heavy masonry, with guard walls from 10 to 20 feet above the coping of the dams, the head walls and upper gates of the locks being carried up to the same height as a protection during floods.

On the Greenbrier the maximum freshet-rise is about 20 feet. It varies on different portions of New River, rarely exceeding 8 feet at Richman's Falls; 30 to 35 feet from Stretcher's Neck to Bowyer's, or, perhaps, to Miller's Ferry, and for a few miles below the latter point from 40 to 50 feet. At the Blue Hole, where the river, having fallen 62 feet among precipitous cliffs in the preceding two miles, turns at a right angle and meets a lighter grade, the engineers of the Chesapeake and Ohio Railroad have found unmistakable signs of high water, 69 feet above the ordinary surface. At these points the locks will be, of course, submerged, but their construction will be such as to preserve them from injury.

The lock-gates will be made of iron frame, and covered with plank, and furnished with suitable gearing for maneuvering them. By reason of the necessary height of the upper gates, they will rest on breast walls, and the influx-valves will be placed in culverts communicating directly with the pool. The efflux-valves will be placed in the lower gates.

The large locks on the slack-water will transmit the daily tonnage estimated for the canal in 120 lockages, requiring for a maximum lift of 15.5 feet, (on the Greenbrier,) with 25 per cent. added for waste, 120 by 200 by 40 by 15.5 by 1.25, cubic feet	18,600,000
Which being supposed necessary for 120 days, the required supply will be, cubic feet	2,232,000,000
But Anthony's Creek reservoir will furnish, beyond the quantity needed for the canal, cubic feet	3,512,496,220
Showing a surplus to meet contingencies of, cubic feet	1,280,496,220

During the last summer and early fall the Greenbrier was very low, said to be lower, indeed, than ever before observed by persons living at Greenbrier Bridge, but was swollen by rains before an opportunity offered to gauge it. I rely, therefore, for the low-water flow at the bridge upon Captain McNeil, who found it, as stated above, 97 feet per second, at the mouth of Howard's Creek, just below Greenbrier Bridge. A gauge made by myself, some 16 miles lower down, gave 1,000 feet per second. The river had been much higher, but had fallen to within 8 to 10 inches of its lowest period at the point where the gauge was made, and was very slowly falling. Any calculation of the relative discharge at its lowest stage, based only upon the relative section and perimeter, must, in my judgment, be speculative when applied to a river formed, like the Greenbrier, of alternate pools and rapids. The application of the formula gives as the low-water discharge at the point 603 feet per second, which must be far in excess of the truth. Not many streams empty into the river between Howard's Creek and this point, but I am of opinion that considerable quantities of water are furnished from the limestone beds which are here underlaid at a slight depth by the sandstone. The discharge of New River, when said to be at a low stage, though not its lowest, was found to be 2,000 feet per second.

Besides the Gauley, several streams of considerable importance empty into the New River below the place where the gauge was made, yet the ordinary low-water of the Kanawha, which unites the discharge of New River with that of the Gauley, is but 1,300 feet per second, and has been as low as 1,100 feet at Buffalo Shoals, thirty-five miles below Charleston. If, therefore, the water of New River sinks, as has been supposed, it does not come out at the Salines or any other point of the upper Kanawha, but the fact is, as before stated, that the minimum flow of a stream of these varying characteristics cannot be directly deduced from the observation made at any other stage.

From Lyken's Shoals to the Ohio, at Point Pleasant, the distance is 85.1 miles, and the average fall about .873 foot per mile, and as with this fall an open navigation is practicable it is also highly desirable.

Among the plans proposed, that of sluice dams, by Mr. Fisk, is the most simple of application and certain in its results. His theory is to grade the river by means of dams at the shoals, to be spaced about one-quarter of a mile, containing sluices of uniform dimensions, (I would fix them at 100 by 7 feet,) and with but 6 inches fall at each dam, thus lengthening the steep grade of the shoal, and lightening it by extending the fall over more distance. The resistance to a tow of loaded boats passing these sluices up stream will be greater than has been supposed, (for the tow will completely fill the sluice,) and will require some modifications of the present method of towing.

The low-water flow of the Kanawha, being but 1,100 to 1,300 feet per second, is not sufficient to fill such a sluice, but will require from 800 to 1,000 feet more. To obtain this we must have recourse to a reservoir, and I therefore include in the estimate the cost of one surveyed by Mr. Ellet for this purpose, described by him as Meadow Reservoir. His estimate, as revised, amounts to $529,080, but as one with a tenth of its capacity will be sufficient, I have placed it at $250,000. To this is added the estimate for dams, &c., by Mr. Byers, increased by 80 per cent., to allow of more permanent constructions than those proposed by him, as well as a greater depth of water, $723,900, making a total of $973,900.

The mean velocity of current in the sluices will be 3 feet per second, or about two miles per hour, which will be encountered for a short distance only, and the wide pools between the dams will offer every facility for the passage of boats moving in opposite directions. In case the system of towing cannot be changed to occupy less width than is now usual, (I see no reason why it should not be,) then recourse must be had to locks and dams, for which the conditions are peculiarly favorable if any obstructed navigation can be tolerated. An approximate estimate shows the cost of such an improvement to be about $1,000,000.

TIME OF COMPLETION.

A material question is the time which will be required for the completion of this work. Provided funds are supplied to keep pace with their economical expenditure, the opening of the line will be governed by the time necessary to complete the long or Lorraine tunnel. If we suppose a progress of 30 feet per month to be made in each shaft, and 100 feet per month in each heading, (and double this has been made in the Mont Cenis Tunnel,) then the longest time will be consumed in the west heading of shaft No. 4, and the east heading of shaft No. 5, which will require five years and two months from the date of commencement. Ten months may be consumed in preparation and in trimming up after the opening is made through; we may therefore safely say that the work can be completed in six years from the time it is put into the hands of a competent contractor.

As these shafts will be the deepest on the line of tunnel, (the portion between them lies under the summits of Kate Mountain,) I will not venture to predict what character of rock will be encountered. If it should be slate or shaly sandstone, much more rapid progress can be made. If compact sandstone or limestone, even then the rate of 100 feet per month ought to be attained.

Much water will probably be met with, and will require the use of the most improved pumping machinery. The great quantity of material to be removed—about one ton in every four minutes—will be facilitated by the large area of tunnel, but will require skillful management, and the best mechanical helps.

CHESAPEAKE AND OHIO RAILROAD.

From the mouth of Howard's Creek to the mouth of Scary, about sixteen miles below Charleston, the Chesapeake and Ohio Railroad follows the valleys of the Greenbrier, New, and Kanawha Rivers.

The location made for the Covington and Ohio road, of which this is the successor, took into view the construction of the water-line, and was placed at an elevation above the reach of floods as increased by the dams to be erected, and high enough to permit the passage of boats beneath its bridges. The location by the present company, however, is but a few feet above the maximum freshet-height of the river in its unimproved condition, and will be flooded in high water if this project is carried out. But little work, however, has yet been done on it which would not be available for a location high enough to be out of the way of the water-line; but it is understood that the entire road will be placed under contract in the spring, and it becomes, therefore, of great importance that the question of the construction of the water-line be determined at an early day, and an arrangement entered into with the railroad company for the necessary changes in its location. Negotiations have been opened, and propositions made, by the James River and Kanawha Company, with a view to arrange the terms upon which the alterations would be made by the railroad, but so far, I am advised, without definite results.

MODE OF TRANSPORTATION.

Through-freights will be transported by barges, towed by steam, from the mouth of the Kanawha to Greenbrier Bridge, and thence by canal-boats to Richmond, moved, I would say, by horse-power, were I not satisfied that steam will be introduced as the motor on large canals before this work can be constructed.

For some classes of freights it may be more economical to use barges small enough to go through on the canal, two of which can pass the river-locks at once, and thus avoid the necessity of breaking bulk. But I apprehend that for grain, which will probably form the greater part of the freight, the larger barges will be used, and the cargoes transferred at Greenbrier Bridge. With proper elevators the cost of transfer need not exceed 1 cent per bushel.

In the present uncertain and embarrassed condition of the Ohio and Kanawha navigation, heavy freights are carried for about 1.8 mills per ton per mile. It is not, then, too much to assume that by a systematic organization, and the use of larger boats, the cost may be reduced to 1¼ mills. We will, however, put it at 2 mills.

I estimate the cost on the Greenbrier and New Rivers at 3 mills per ton per mile, and on the canal at 3.6 mills, making an average of about 3.16 mills per ton per mile, or $1 52½ for the whole distance from the Ohio to Richmond.

The entire cost of the improvement will be about	$48,000,000
Six per cent. on which is	2,880,000
Annual cost for maintenance	387,200
Total	3,267,200

With a trade of 5,000,000 tons per annum a charge of 65.3 cents per ton on the through-route will pay these expenses, at the rate of 1.34 mills per ton per mile, making total *cost*, with tolls, but without profits to carriers, 4.5 mills per ton per mile.

The average charges, for ten years, from Chicago to New York, have been, by the water-lines, $7 66½ per ton, and by Central Railroad, $14 31. From St. Louis, flour has been carried to New York, by rail, for $13 per ton, and by way of New Orleans for $11 50.

The actual cost of transportation per ton per mile by the Virginia water-line would be as follows:

From St. Louis to mouth of Kanawha, 903 miles, 0.3 cent	$2 71
Mouth of Kanawha to Richmond, 480 miles, at 0.316 cent	1 52
Richmond to Hampton Roads, 100 miles, at 0.25 cent	25
Two transhipments	40
Cost from St. Louis to New York, without tolls on canal or profits to carriers	4 88

From Dubuque, Iowa, one of the points on the Mississippi nearest to Chicago, to New York, by rail, is 1,145 miles. One ton of freight moved over this distance, at 0.12 cent per mile, would cost $13 74.

From Dubuque to New York, by rail to Chicago, and thence by the northern water-lines, cost as follows:

Dubuque to Chicago, by rail, 188 miles, at 0.12 cent	$2 25.6
Chicago to Buffalo, by the lakes, 1,042 miles, at 0.2 cent	2 08.4
Buffalo to West Troy, by Erie Canal, 350 miles, at 0.4 cent	1 40
West Troy to New York, by Hudson River, 151 miles, at 0.25 cent	38
Three transhipments	50
Total	6 62

From Dubuque to Hampton Roads, by Virginia water-line, will cost:

Dubuque to mouth of Kanawha, by river, 1,367 miles, at 0.3 cent	$4 10
Mouth of Kanawha to Richmond, 480 miles, at 0.316 cent	1 52
Richmond to Hampton Roads, 100 miles, at 0.25 cent	25
Two transshipments	40
Total	6 27

Showing a difference from Dubuque of 29 cents per ton by the Virginia water-lines over that by the lakes, although the difference of distance against it is two hundred and forty-one miles. Of all points on the Mississippi, Dubuque is one of the most favorable to the northern lakes in this comparison.

The Virginia route is open several months during which the northern lines are closed by ice, and is free from the dangers which affect that navigation during the busiest months of the grain movement.

In addition to through-freights from the West to the seaboard, the trade of the Virginia line will be increased by local developments.

The coal deposits of the Kanawha have been worked with marked success, though to a comparatively limited extent. Bituminous cannel and splint coals are found in abundance, and are mined with very little cost.

The iron ores of East Virginia, lying near the line of the canal, cover large tracts of country. They are of excellent quality, and will be extensively developed by cheap coal from the Kanawha.

Three-fourths of the salt-works formerly so productive are now, I am informed, "dead-rented"* to proprietors of other works on the Ohio, to prevent their competition. They are capable of any required development.

The general argument for the construction of this work is to be found in the necessity for more lines of transportation, and for cheaper rates from the northwest to the Atlantic, as set forth in the memorials to Congress of the States of Virginia and Iowa.

Time has not permitted me to present from original sources such statistics of western production and transportation as would have been desirable.

The surplus products of the Northwest exceed twenty-five millions tons, of which from five to six millions come to the Atlantic States over our four trunk lines of railway and the Erie Canal.

The total wheat and corn crop of 1868 was nearly 1,000,000,000 bushels; of which there were received at the lake ports, 84,000,000 bushels; shipped to New York by water, 53,000,000; by rail, 14,000,000; and exported 30,000,000 bushels. In 1869 the receipts at lake ports were 113,000,000 bushels; at New York, 62,000,000 bushels; and the exports for the year ending June 30, 1869, 35,000,000 bushels.

Under the stimulus of high prices for farm products since the war large quantities of grain have been sent forward at rates for transportation which they cannot hereafter pay. During the season of 1870 the reduction of tolls and freights on the Erie Canal made up, to some extent, for the fall in prices, and considerable quantities were sent, by way of the St. Lawrence, through Canada.

> The growth of the West constantly keeps ahead of the progress of the railroads, and the result is, the transportation companies absolutely control the rate of freight. The present railroad lines having as much freight as they can carry, there is no motive for competition between them, but rather for collusion to secure the highest possible rates.
>
> So heavy are the transportation taxes now laid on this trade (that of the Ohio and the Northwest) that, at the present time, (April, 1870,) breadstuffs and produce to the value of hundreds of millions is perishing in the West, for the reason that it would cost more to move it to the seaboard than it would bring when it reached there. This fact and the consequent discouragement of production is a cause of serious alarm, when we consider that it is on a western produce that we must, in a great measure, depend to make up the balance of our foreign trade. Without cheaper transportation, however, we cannot compete with Russia and other grain-producing countries in foreign markets; but with free navigation from the Mississippi, via the Wisconsin and Fox Rivers, the lakes, and the Erie Canal, to the seaboard at this point, the agricultural resources of the country would be more fully and properly developed, the volume of our export trade largely increased, and prosperity of our State permanently assured.—*Hunt's Merchants' Magazine, April*, 1870.

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* Paid to remain idle.

But I apprehend that this portion of the argument will be admitted by all:

1. That the depression of business is greatly affected by the high cost of food.
2. That cheaper transportation will give cheaper food at the East.
3. That western agriculture will be stimulated to increased production.
4. That the quantity and value of our exports will also be increased.

To those who have investigated the subject the great economy of water transportation is well known, and it is generally conceded by the mercantile community.

We have but one canal connecting the western waters with the Atlantic—the Erie. Of its importance, notwithstanding the rapid growth of the railroad system of the State, as a source of wealth and an element of commercial prosperity, we can best judge from the tonnage statistics of the State engineer's report, which show that, during the seven months of navigation in 1869, the canals moved more freight than were carried by all the railroads of the State during the year.

The Erie Canal proper has cost in construction, improvement, repairs, and management, with interest on all expenditures, $140,430,953, and has paid in tolls, with interest on all sums received, $181,828,603, or a net profit, over principal and interest, of $41,397,650.

Notwithstanding the high rate of tolls which produced this enormous profit, the charges for transportation by canal have generally been about half as much as by rail. Although at times the railroad rates have been reduced to the same as the canal, they have then been less than cost, and required the imposition of excessive charges on local trade to make up the loss.

For the year 1867, canal charges, on the round trip from Buffalo to Albany, were averaged at 1 cent per ton per mile, 44 per cent. of which was toll.

The average receipts per ton per mile during the years 1865, 1866, and 1867 were, on New York State canals, 1 cent; New York Central Railroad, 2.92 cents; Erie Railroad, 2.42 cents.

The policy of low tolls on her canals has been inaugurated by the State of New York with the view to retain and increase the immense trade brought by them to her emporium. The profits of transporting, handling, selling, and shipping will advance her prosperity far more than the receipts for tolls. Another enlargement of the Erie Canal is urged, at a cost of $10,000,000, for the purpose of reducing cost of transportation from 2.16 to 1.7 mills per ton per mile.

The Pennsylvania canals, so long a burden and expense to that State, though of small dimensions and unfitted for the most economical transportation, having passed into the hands of the Pennsylvania Central Railroad Company, under the skillful management which has accomplished such great results for the railway, are being brought into condition to facilitate and cheapen transportation on their lines.

Hon. William I. McAlpine, one of our most eminent engineers, in an address delivered by him in 1868, states the case with so much force and with such authority that I introduce here his remarks:

> The Erie Canal now conveys one-fourth of the whole of the exports of that vast interior region which I have already described, and as much of it during its six months of uninterrupted navigation as all of the trunk railways together during the same term.
>
> Every canal-boat which comes to this city with an average cargo is more than the average of the New York Central Railroad trains. In the busy canal season, more

than one hundred and fifty such boats come daily to tide-water, and the New York Central Railroad traffic never reaches thirty trains per day.

Such a canal traffic would make more than twenty miles of railroad cars, and there is neither room nor convenience for discharging one-fourth of that number. The slow plodding canal-boat attracts no attention, while the bustle, noise, and whirl of a freight train creates a sensation in every village through which it passes. The locks on the canals act as regulators of the boats, which are separated just the distance which they would move during one lockage, and hence the canal business proceeds methodically, and gives no idea of its great volume. Nor is this appreciated until some stoppage occurs, and then a delay of twenty-four hours will accumulate hundreds of boats, enough to fill the Central track-half way from here to Utica.

One of the commissioners told me to-day that a break at Schenectady, which required six days to repair, filled the canal to Utica on one side, and to the Hudson on the other.

Mr. Drullard told me last fall that the freight which has frozen up on the canal would, (with their other business,) occupy all the power of the Central six months to transport it to the Hudson. Six days more of canal navigation would have brought every pound of this freight to tide-water.

Imagine, if you can, what would be the effect of a catastrophe that should stop the navigation of the canals for *one season*. All of the New York roads could not transport *one-tenth*, and all of the roads to the seaboard *put together*, not *one-fifth* of it. Half the merchants of New York connected directly or indirectly with this canal traffic would be bankrupted, and their rivals in Portland, Boston, Philadelphia, and Baltimore, would be correspondingly profited.

It is evident that *all* the channels of trade in operation between the Atlantic and the West, as now managed, are inadequate to accommodate or perform it at a cost which, in time of low prices, will allow the agricultural products of the West to be transported.

In a broad view of the subject, there is no antagonism between the interests of the canals and railways of this State. They have each their appropriate functions to perform, and while accomplishing these, each of them is adding to the business of the other.

A prominent cause for the transfer of much of the legitimate business of the canals to the railways of our State arises from the fact that the former is under individual management, and the latter is controlled by politicians. As the manager of several western railways, where the direction and route of a large transport was controlled, I can safely say that I was never for a week without the presence of a solicitor of freights from one or more of the New York railways, and in ten years of such active management I never once had an applicant to direct our freights over the Erie Canal. All that took that direction (and it was no inconsiderable amount) was from the sheer force or influence of its own merit.

The reports of the railroad companies do not furnish the means of determining the cost to them of transportation. The most favorable statements represent it to be 1.2 cent per ton. Coal in large quantities can be carried at less cost.

It has been urged as against the project of a new water-line that railroads of easy grades and curves, and running at low rates of speed, could carry freights at almost nominal rates. Undoubtedly, by such means, with a track exclusively for slow freights, and perhaps by adopting, to some extent, the lessons of the narrow-guage railway, railroad transportation may be very much cheapened. Good authorities maintain, however, that a reduction of speed below eight to ten miles per hour is not economical, and the third track adds materially to the expense. But the first argument is the fact that none of our through lines have thought it worth while to inaugurate such a system, while they have plenty of freights at higher and better paying rates. Freights of certain classes belong legitimately to the railroad; they are of greater value and can afford to pay higher rates, and for such articles the great saving in time, by which a larger business can be done on the same capital, will always give it the preference. To these the water-line can lay no claim. Its specialty will be the transportation of such as would scarcely be borne by the railway in any case, such as are now "perishing in the West because it would cost more to move them to the seaboard than they would bring when they reached there."

Over the water-line, by the lakes, this one has the advantage of being but little obstructed by ice, and it is free from the heat and dampness of the New Orleans route, which for more than half of the year cannot, without risk, be used for grain and other articles.

But the tendencies of the great railway companies are towards consolidation. Among them there can be no real competition, attempts at which always end in combination. "It is on the water-way, * * rather than on new lines of railroad, that we must chiefly rely for the accomplishment of the much needed reforms. Lakes, rivers, and canals are the only sure protection against railroad monopoly."

If it should be determined to prosecute this work, although it is of the greatest importance to the interests involved that its completion should not be delayed, at least one season will be required for the proper examination of the line, its relocation, survey, preparation of plans, and getting it ready for contract.

Some time might be saved by commencing work on the deep shafts of the Lorraine tunnel as soon as a careful location could be made.

These necessary surveys and preparations will cost about $80,000. Work on the tunnel shafts to the amount of $10,000 to $15,000 could be done before the spring of 1872.

The above estimate is not intended to provide further information to enable Congress to decide the question, but supposes the project adopted and the work to be prepared for contract.

The estimated cost being nearly $48,000,000, and the time required six years, an average expenditure of $8,000,000 per annum will be necessary.

Considering that this water-line will be closed at its junction with the Ohio for about three months in each year by low water in that stream, I was at first disposed to recommend the improvement of the rivers to a less depth than that adopted for them, but there is no reason why the capacity of the line should not be kept up during such periods as furnish sufficient water, more particularly as at such times transportation may be cheapened by the use of boats made to pass through the canal, without breaking bulk, from the point of shipment on western waters to Richmond or Hampton Roads.

At the risk, however, of touching questions not committed to me, I will call attention to the fact that the water-line involves the improvement of the Ohio River from the mouth of Kanawha down. It is difficult to explain why a river of such capacities should have been left in its present condition. With a low-water discharge of 3,500 cubic feet per second, sufficient at such times to fill a channel 200 feet wide and 7 feet deep, it affords on its shoals a depth only one-fourth as much, spread over a width of about one thousand feet.

The following is the estimated cost, in detail, of the improvement, as recommended, from mouth of Fork Run to mouth of Kanawha River:

Estimate from Fork Run to Greenbrier River.

Grubbing and cleaning 67 miles, at $200	$13,400 00
141,700 yards of embankment, in addition to price for excavation, at 10 cents	14,170 00
313,149 yards earth excavation, at 30 cents	93,945 00
1,203,865 yards rock excavation, at $1 25	1,504,831. 00
13,000 yards of slope-wall, at $1 50	19,500 00
6,500 yards of lining, at 40 cents	2,600 00
8 locks, at $27,000	216,000 00

1 lock, at $50,000		$50,000 00
3 culverts		5,000 00
2 waste-weirs		3,000 00
7 overfall wastes		5,600 00
1 aqueduct wooden trunk, to carry Fork Run over cut		5,000 00
2 bridges, at $4,950 and $5,625		10,525 00
Tunnel:		
40,580 feet long=2,333,350 yards, at $5, including excavation for arch-shafts, 2,700 feet linear	$11,666,750 00	
14,400 yards, at $20	288,000 00	
Masonry of arch and tow-path, 162,320 yards, at $8	1,298,560 00	
		13,253,310 00
Feeder:		
16,000 feet long	112,000 00	
Dam, with abutment and guard-gates	41,000 00	
Embankment, 8,000 yards	2,000 00	
		155,000 00

Anthony's Creek Reservoir, (Mr. Lorraine's estimate.)

456,000 yards embankment, at 30 cents	$136,800 00	
977 yards masonry arch, at $12	11,724 00	
2,989 yards masonry abutments, at $8	23,912 00	
14,000 bushels cement	10,500 00	
950,000 pounds iron pipes, at 8 cents	76,000 00	
		258,936 00
Land damage, 200 acres, at $40; 3,000 acres, at $10		38,000 00
		15,636,757 00

Greenbrier and New Rivers.

989,130 cubic yards of masonry, at $10		$9,891,300 00
22,852 cubic yards concrete, at $5		114,260 00
400,000 cubic yards riprap, at $1 50		600,000 00
6,882,000 feet, board measure, of timber and plank, at 5 cents		344,100 00
1,401,622 cubic yards of earth excavation, at 40 cents		560,648 00
168,600 cubic yards of rock excavation, (partly under water,) at $1 50		252,900 00
1,470,000 cubic yards embankment, at 20 cents		294,000 00
77,333 cubic yards of puddling, at 25 cents		19,333 00
Timber and iron in coping of dams		99,000 00
550,000 cubic yards of graveling, at 40 cents		220,000 00
Lock-gates, $8,000 per lock; valves, &c., $1,200 per lock		552,000 00
55 lock-houses, at $1,000		55,000 00
For dam and lock at Lyken's Shoals		130,000 00
Land damages, 150 acres, at $100	$15,000 00	
Land damages. 9,600 acres, at $10	96,000 00	
		111,000 00
		13,243,541 00

RECAPITULATION.

From mouth of Fork Run to Greenbrier River	$15,636,757 00
Greenbrier and New River...........................	13,243,541 00
Kanawha River..	973,900 00
Add 10 per cent. for contingencies	2,986,420 00
Total from Fork Run..................................	32,840,618 00

Respectfully submitted.

WM. R. HUTTON, *Civil Engineer.*

Major WM. P. CRAIGHILL,
United States Engineers.

Q 13, (3.)

BUCHANAN, VIRGINIA, *December* 28, 1870.

COLONEL: This survey of the eastern division of the James River and Kanawha Canal, which is made under an appropriation by Congress, and by you committed to my charge, with instructions to "embrace that portion of the canal definitely located and in use," begins at the mouth of Fork Run, in Alleghany County. It includes a portion of the located route known as the fourth division, which extends to the town of Covington, in Alleghany County, and is 17.37 miles in length. This portion of the fourth division is common to either line that may be selected for the passage of the Alleghany Mountains.

The third division extends from the town of Covington to Buchanan, in Botetourt County, and is 47.27 miles in length. The portion of the fourth division, above alluded to, and the third division, comprise a part of the canal that has been "definitely located," and is 64.64 miles in length.

The second division extends from the town of Buchanan to the city of Lynchburgh, and is fifty miles in length. The first division extends from Lynchburgh to and including the basin in the city of Richmond, and is one hundred and forty-six and a half miles long, and, with the connection through the city of Richmond, one mile in length, known as the tide-water connection, comprises all that portion of the eastern division in use, and is one hundred and ninety-seven and a half miles long, making the aggregate length, from tide-water at the city of Richmond to the mouth of the Fork Run at the eastern base of the Alleghany Mountains, 262.14 miles.

Before proceeding with the details of the cost of the respective subdivisions, I will give the dimensions which have been assumed as the basis of the calculations of the cost of the work, viz:

A canal of 70 feet water-surface and a depth of 7 feet; towing-path 12 feet wide and berm-bank 8 feet wide; the interior slopes to be 2 base to 1 perpendicular, and exterior slopes 1½ base to 1 perpendicular. The locks to be 120 feet long between the gates, and with a width of 20 feet in the chamber. The locks to be of cut-stone throughout, and in all respects of first-class masonry. The estimate contemplates first-class work of all descriptions.

The fourth division is located in the valley of Dunlap's Creek, and consists of 4.19 miles of slack-water navigation and 13.16 miles of canal. On this subdivision the works of art are thirty-five lift-locks and guard-locks, having an aggregate lift of 376 feet; eight dams, seven to be built of timber and one of stone, varying from 104 to 390 feet in length, and ranging from 10 to 35 feet in height; thirty-four road, farm, and towing-path bridges; one culvert; two waste-weirs and one waste; one aqueduct across Dunlap's Creek of two spans of 65 feet each, and one across Jackson River of two spans of 100 feet each, the last one connecting it with the third division. The cost of this portion of the fourth division is $2,206,795 45, or $127,046 60 per mile.

The third division extends from Covington to Buchanan, distant forty-seven miles, of which forty-one miles are canal and six miles slack-water navigation.

On this division the principal mechanical structures are thirty-six lift-locks, two guard-locks, and one guard and lift lock combined, with a total lockage of 436¾ feet; five aqueducts across James River, each about 320 feet long; aqueducts across Long's Entry and Sinking Creeks and Pounding Run of 50 feet span each; fifty-three farm, road, and towing-path bridges; one towing-path and road bridge across James River, 393 feet long; eleven culverts, from 4 to 10 feet span; thirty-three square drains, 2 and 3 feet span; three dams across James River, from 250 to 365 feet long, one to be constructed of timber and two of stone; and two tunnels, the Marshall, 1,900 feet long, and the Mason Tunnel, 198 feet long, by which five and five-eighths miles in distance are saved. The first fifteen miles of this work above Buchanan were put under contract in 1853, but for want of funds operations were suspended in 1856. Of this work there are completed ten lift-locks, the abutments and piers of three of the aqueducts across James River, and the abutments and piers for the bridge across James River. The foundation of two of the dams up to the surface of low water have been put in, about 800 feet of the Marshall Tunnel has been excavated, and work as follows has been completed, viz: the Mason Tunnel, two culverts, abutments for three towing-path bridges, and several miles of towing-path on the slack-water navigation made by the Catawba and Gwynn Dams. Much of this work is available for the enlarged dimensions proposed. Where the dimensions of the structures completed and begun are not suited to the enlarged dimensions, the estimate covers the cost of taking down and rebuilding on the enlarged plan.

The cost of this division will be $4,036,577 11 or $86,097 38 per mile.

The third division, and the portion of the fourth division for which estimates of cost are submitted, were located with great care by Mr. E. Lorraine, chief engineer of the canal, after repeated examinations had been made on every route through the valley of Dunlap's Creek and Jackson and James Rivers which offered any advantages for the location of a canal. These various surveys were made by and under the direction of Judge Benjamin Wright, Messrs. Charles Ellet, E. H. Gill, Walter Gwynn, and other engineers of experience and skill in the location and construction of canals. The location, as finally adopted, is believed to occupy the route offering the greatest facilities for the judicious and economical construction and maintenance of a canal.

My operations in the field began on the 21st of September last, and were expected to include also a survey of the first and second divisions, with a view to their enlargement to the dimensions mentioned in the beginning of this report. The dimensions of these divisions are generally a width of 50 feet at the water-surface, an intended depth of 5 feet of water, locks 100 feet long between the gates, with a width of 15 feet in the chamber. The survey of the second division was completed, and is 50 miles in length, comprising twenty-two miles of canal and twenty-eight miles of slack-water navigation.

The principal mechanical structures on this division are 37 lift and guard locks, having a total lift of 299 feet; four stone dams and seven timber dams across James River, varying from 354 to 850 feet in length, and from 14 to 36 feet in height; one aqueduct of 50 feet span; forty-eight square drains, 2 and 3 feet span; seventeen towing-path and farm bridges; one towing-path and road bridge across North River, 253 feet long; seven wastes and one waste-weir.

The estimate covers the enlargement of the trunk of the canal, raising the towing path and berm banks, increasing the height of the locks in use two feet, giving the same increase of height to the dams, lengthening the culverts, the construction of new locks of enlarged dimensions and of the same lift alongside the locks now in use, and, in all the details, to make the improvement first class.

I made changes in the location at lock No. 25, the outlet-lock into the pond, created by the Indian Rock Dam, the entrance being very objectionable. With the location now proposed, the entrance at both ends of the lock will be very good. At Indian Rock the estimate embraces an amount sufficient to change and improve the entrance to the guard-lock at that point.

The estimate contemplates the erection of a towing-path and road bridge across James River, at the Blue Ridge Ferry, a few hundred yards above the Cushaw Dam, high winds and water frequently making the crossing dangerous, and at times impracticable. The erection of this bridge obviates these delays. If the work was to be put under contract, I would advise that the pond be entered about half a mile further from the dam than at present, and that the crossing be made the same distance from the dam. The canal here passes from the north to the south side of the river.

At lock No. 6, the outlet into the pond created by the Coleman Falls Dam, another change is proposed, viz, to cross Read Creek by an aqueduct of 50 feet span, and to enter the pond some distance below the mouth of the creek. The object of this change is to avoid the deposit of sand made at the entrance to the lock by the creek, the site selected for the new lock being more favorable than one alongside the present lock. At present frequent delays are caused to navigation, and much expense incurred in removing these deposits by dredging.

Admonished by the fresh of September last, the highest which has occurred within a century, and from an inspection of the injuries received at several of the dams, I am convinced that they resulted from the water-way being too much contracted. The abutments of the dams are connected with the head-walls of the guard-locks by walls of rubble masonry, generally 25 feet high above canal bottom, and varying from 40 to 360 feet in length. At Big Island, Coleman Falls, and Judith Creek Dams they were, respectively, 256, 354, 256½ feet long, and the fresh swept them down to the level of the dams. I have estimated for lengthening the Big Island Dam 150 feet, making the entire length 577 feet; for Coleman Falls Dam an increase of 168 feet is proposed, making the entire length 522 feet; for Judith Creek Dam an increase of 150 feet, making the entire length 575 feet. These additions, and other safeguards estimated for, will render these dams safe against such freshes as that which induced these alterations. With the exception of Quarry Falls Dam, the water-way of the dams above the mouth of North River is sufficient, and no danger is to be apprehended. I have provided for lengthening the Quarry Falls Dam 100 feet.

By the second division the passage of the Blue Ridge Mountains is made. The length of canal through the mountains is seven and a half miles. From the mouth of North River, in Rockbridge County, where the gap in the mountains begins, the work is heavy and of an expensive character, as is also generally the case from this point to Lynchburgh. The valley is narrow, and the river hills leave but little space between their bases and the river.

The estimated cost of this division is $2,092,008 51, or $41,840 17 per mile.

The first division, extending from the city of Lynchburgh to and including the basin in the city of Richmond, is one hundred and forty-six and a half miles long, comprising one hundred and thirty-seven and three-fourths miles of canal, and eight and three-fourths miles slack-water navigation. The dimensions of the first division are generally the same as those of the second division, the locks being of the same size.

The lockage from the basin in Richmond to the city of Lynchburgh is 429 feet.

The principal mechanical structures are fifty-two lift-locks; four guard-locks; four principal dams, viz: Waterworks Dam, Lynchburgh, Joshua Creek, Tye River, and Maiden's Adventure Dams; nine other dams across James River, or to islands in the river which serve as feeders to the canal, or for connections with the south side of the river; eleven aqueducts, three of which have wooden trunks, the remainder being of cut stone, with spans varying from 20 to 65 feet; one hundred and ninety-one culverts, with spans from 2 to 30 feet; one hundred and thirty-three farm and wood bridges; three towing-path bridges; nine waste-weirs. Of the locks, twenty-two are built of cut stone, the remainder of rubble masonry, faced with timber, and of the class known as composite locks.

The survey of this division was principally confined to the enlargement of the trunk of the canal, construction of new locks, raising the dams, and altering such other mechanical structures as may be made available. The estimate embraces the construction of a towing-path bridge across James River, at the head of Joshua Creek Pond, 550 feet long. It provides also for the continuation of the thirty-third level, (entered by combined locks of 17 feet 10 inches lift,) from pond created by Tye River Dam, around this pond, crossing Tye River by an aqueduct of three spans of 100 feet each, and locking into the thirty-second level, about 1,000 feet below the present guard-lock. Instead of having combined locks, I divide the lift, and substitute two locks, having lifts respectively of 9 feet 10 inches, and 8 feet, with a level between them of near 1,000 feet in length. The inducements to make this change are, to avoid the danger and detentions to navigation caused by frequent rises in Tye River, which enters James River a few hundred yards above the guard-lock and dam. The deposit of sand made by this stream is immense, causes frequent detentions to navigation, and entails a large and yearly increasing expense for dredging. The dam is needed as a feeder, and will still serve the local trade from the south side of the river.

The time at my command for field-work being insufficient for the completion of the survey of this division, field operations were suspended at the sixty-ninth mile west of Richmond. Hence this estimate is an approximation. The cost of the enlarged locks is accurately given, and the quantity of other mechanical work is known, and can be closely estimated. Average sections are taken, and their cost applied to similar sections.

This and all other preliminary estimates can but approximate the actual cost of construction, but I feel confident that this will be found as nearly correct as such estimates can be made.

The cost of this division is taken to be $4,811,326, or $32,841 81 per mile.

An estimate has been made for a new connection between the first division and tide-water, one mile in length, amounting to $334,937. The lockage between the basin and dock is 69 feet.

Tide-water is reached by a ship-lock 180 feet long between the gates, 35 feet wide in the chamber, having a lift of 15 feet, and 16 feet of water on the miter-sills. The dock is 4,900 feet long, and varies in width from 100 to 200 feet. From the ship-lock to Seventeenth street, 4,100 feet, the depth of water is from 11 to 15 feet. Above Seventeenth street the depth is from 5 to 8 feet. It is proposed to enlarge this dock, and construct a new ship-lock of such dimensions as will admit the largest steamers and sail-vessels into the dock that can navigate the James River, which is now being improved under liberal appropriations made by Congress and the city of Richmond. The estimate for the enlargement of the dock and new ship-lock is $1,300,000.

Estimates in detail will be made and submitted as soon as they can be prepared, giving by sections the quantities and classification of excavations and embankments, quantities of masonry and prices applied, and generally a minute description of the whole line. Such plans and maps as will elucidate them will be submitted with the detailed estimates. It being desirable that at least a partial report of the surveys committed to my charge should be in your hands by the 1st of January, I have been induced to devote the time spent in estimates to the most prominent and expensive points and class of works, and to make as close approximations as time allowed to the cost of less important and less expensive portions. The notes taken in the field were so extended as to enable me to prepare estimates for a canal with a water-surface of 85 and 100 feet in width, if you should desire such estimates.

It will require about one month to complete the field-work on the first division, and make the surveys for the new tide-water connection.

The total cost of the portion of the line considered in my estimates, 262.14 miles in length, with a total lockage of 1,624¾ feet, is as follows:

Fourth division	$2, 206, 795 45
Third division	4, 036, 577 11
Second division	2, 092, 008 51
First division	4, 811, 326 00
Tide-water connection	334, 937 00
Dock and ship-lock	1, 300, 000 00
	14, 781, 644 07

Exclusive of the tide-water connection and enlargement of dock and new ship-lock, the cost is $13,146,707 07, or an average of $50,408 45 per mile. Including these, the total estimate is $14,781,644 07, or an average of $56,418 10 per mile.

No physical difficulties will be encountered in the construction and enlargement of the portion of the line herein reported on, that have not been overcome in the construction of the first and second divisions of the canal, including the old Blue Ridge Canal, and its enlargement to the dimensions of the canal now in use. Far greater difficulties have been repeatedly met and surmounted in this country and in Europe. Increasing the water-surface to 70 feet, and building locks 120 by 20 feet, involves simply so many cubic yards of rock and earth excavation and so many cubic yards of masonry. Many miles of canal in this country have cost as much per mile, with dimensions less than here proposed; some have cost more, and in Europe the cost has largely exceeded the amount estimated in this report for the extension and the contemplated enlargement of the first and second divisions.

The capacity of a canal of the dimensions assumed in this report is well known, and has been clearly stated in tables which show the relative capacity and length of this and other lines between the East and West, as well as the cost of transportation by each.

This information will be found in a report on "The Central Water-line from the Ohio River to the Virginia Capes," prepared by the officers of the James River and Kanawha Company and other gentlemen interested in the proposed improvement. The question of tonnage that would seek this route to tide-water is speculative, and its consideration does not fall within the range of my present duties. The practicability of the construction along this route of an enlarged canal, within reasonable bounds as to cost, having been shown, and its utility too clearly established to require discussion at this late date, there can be no doubt as to the importance of its speedy execution.

Respectfully submitted.

W. G. TURPIN,
Civil Engineer.

Colonel WILLIAM P. CRAIGHILL,
U. S. Engineer Corps, in charge of Surveys in Virginia, &c.

Q 14.

BALTIMORE, MARYLAND, *November* 19, 1870.

GENERAL: I have the honor to submit the following report of my examination at Nag's Head, North Carolina, with a view to the re-opening of Roanoke Inlet, near that place. The act of Congress approved July 11, 1870, provides for either a survey or an examination. No survey has been made, but only an examination, for the reason that already we are provided with Coast Survey charts, which, with the reports of officers of the Corps of Engineers and of civil engineers, are, in connection with the examination referred to, abundantly sufficient to inform us with regard to the feasibility of the project.

This project was first started in 1820 by the State of North Carolina, which employed Mr. Hamilton Fulton, civil engineer to the State, to make the necessary examinations and estimates. The project was to reopen Roanoke Inlet to an extent sufficient for the passage of vessels of considerable draught to and from the ocean. (See two accompanying tracings of Albemarle, Croatan, Roanoke, and Pamlico Sounds, and of the "banks" or island of Nag's Head, from Coast Survey maps.) The reasoning of Mr. Fulton after his examination, according to his report, dated Raleigh, September 15, 1820, to the "president and directors of the board for the internal improvements of North Carolina," may be summed up as follows:

There is no doubt from an inspection of Wimble's map, published by act of Parliament in 1738, that there was an inlet near Nag's Head, by which vessels drawing less than six feet of water could enter from the Atlantic into Albemarle Sound. That inlet became closed from the operation of two causes. The opening between the main land and Roanoke Island called Croatan Sound, and that between Roanoke Island and Nag's Head Island, or the "banks" called Roanoke Sound—originally comparatively narrow—from the great pressure of the water from Albemarle and Pamlico Sounds, according as the wind would force the water through these sounds, eventually became so enlarged by erosion as to weaken the ebb-current flowing through Roanoke Inlet into the Atlantic, and thus permitted the silt along the coast to encroach upon and close the inlet.

Mr. Fulton reasoned further, that as the closing of the inlet was undoubtedly mainly caused by the enlargement of Croatan and Roanoke Sounds, so it was reasonable to conclude that the damming of those sounds, by an embankment across each, in connection with some dredging at the Old Inlet, would again, by the head of water thus produced, open the inlet, and so long as the same condition of things remained, the channel would continue permanently open and be available for navigation.

He proposed two plans for these embankments—one of stone, 15 feet wide at top, with a slope of 3 to 1 on the north side, and a slope of 2 to 1 on the south side; the other plan to consist of two rows of piles, hewn or sawed, on two parallel sides, driven side by side, 20 feet apart; the interior space filled with mud and sand, and the piles protected from the worms by a sloping bank of earth or sand, with an inclination rising to the ordinary surface of the water.

His estimate for the stone embankment was $2,363,483; for timber and stone embankment, $1,206,297; which estimates should be increased 100 per cent. for present valuations, making the former $4,726,966, the latter $2,412,594.

REPORT OF BOARD OF U. S. ENGINEERS ON MR. FULTON'S PLAN.

On the 29th of December, 1820, Hon. John C. Calhoun, Secretary of War, transmitted to the governor of North Carolina a report of the Board of Engineers to the Chief Engineer, Colonel W. K. Armistead, dated December 15, 1820, upon the plans of the civil engineer of North Carolina, Mr. Fulton, for the internal improvement of that State, made in compliance with a request from the board of public works of North Carolina. This board, consisting of S. Bernard, brigadier general, C. Gratiot, lieutenant colonel of engineers, and Joseph G. Totten, major of engineers and brevet lieutenant colonel, with some exceptions, approves the plan

2d. In regard to the expense, the board remarks:

> Mr. Fulton, for the stone embankment proposed by him, finds an expense of $2,363,483, and for that of earth and timber, $1,206,297. It occurs to us that clearing out the channel and inlet, unless it be thought improper to give thus much toward the formation of a bar, may be chiefly committed to the current, especially if advantage be taken of a moment of greatest elevation within and depression without.

3d. In regard to the advantages resulting to the State, the board remarks:

> If the design can be proved practicable and of permanent utility, the propriety of its abandonment or of its completion will depend chiefly as respects the State on the answer to this question. Desirous as we are to aid in the solution of this important question, it is one so involved by the particular interests of the State, with which we are not at all conversant, and by a species of commerce not submitted to registry, and of the value of which we can make no estimate, that we find ourselves unable to offer any assistance. It is certain, however, that the observation of Mr. Fulton on the greater safety from shipwreck, and the economy of time which will result to the commerce of Albemarle Sound, points out advantages which deserve to be highly valued.

4th. The board remarks in regard to the execution of the project on the interests of the Union, as follows:

Without entering into an examination of the political effects of the proposition which has come under our consideration, and in which the particular interests of the State may possibly run counter to those of the Union, an examination to which we do not consider ourselves called by our instructions, nor qualified by due preparation, we shall merely remark that if the plan be carried into successful execution, whether we consider the profits of commerce, the dangers of shipwreck, pursuit by an enemy, or convenience as a point of departure and refreshment for our own privateers and vessels of war, a harbor will be formed precisely in that part of the coast where it is most needed.

PLAN OF CAPTAIN HARTMAN BACHE, CORPS OF TOPOGRAPHICAL ENGINEERS.

Under date of February 12, 1829, Captain Hartman Bache made his report upon the result of the operations called for by the instructions of the board of engineers, prepared by order of the Engineer Department, and predicated upon the act of Congress of May 20, 1826, requiring a survey of Roanoke Inlet and Sound, with a view of ascertaining the practicability of making a permanent ship-channel between Albemarle Sound and the Atlantic Ocean, at Roanoke Inlet or elsewhere, and a statement of the cost of effecting the object.

Captain Bache says:

That there was originally an inlet at Roanoke Island, admits of no doubt. Indeed, if the fact could not be established as a matter of history, we have the evidence of those now living for the truth of such an opinion.

Mr. John B. Etheridge, now sixty years of age, living on the north side of Oregon Inlet, nine miles below Nag's Head, has informed me that Roanoke Inlet closed in 1819, to his personal knowledge. When a boy, he recollects passing through the inlet in a fishing-boat, and that they had to wait for high water.

But in the "History of Carolina, by John Lawson, Gentleman, Surveyor General of North Carolina," London, 1709, we have on page 61 a general description of the coast in the following words:

This part of Carolina is faced with a chain of sand-banks, which defends it from the violence and insults of the Atlantic Ocean, by which barrier a vast sound is hemmed in, which fronts the mouths of the navigable and pleasant rivers of this fertile country, and into which they disgorge themselves. Through the same are inlets of several depths of water. Some of their channels admit only sloops, brigantines, small barks, and ketches, and such are Curritue, Roanoke, and up the sound above Hatteras, whilst others can receive ships of burden, as Ocracock, Topsail Inlet, and Cape Fair, as appears by my chart.

Captain Bache expresses in his report a general concurrence in the correctness of the views taken by the engineer of North Carolina, Mr. Fulton, and then gives the following as the result of his observations:

1st. That Roanoke Inlet existed from the time of the earliest settlement of the country to its final closing within a few years.

2d. That although its capacity for entrance might have been good, yet in consequence of the limited depth of water within the sound, its usefulness was confined to vessels of a light draught.

3d. That its gradual filling up and final disappearance was in consequence of the continual increasing vent given to the waters of the sound, because of the washing away of the marshes near Roanoke Island.

4th. That if, in the foregoing, the proper reasons had been assigned for such a result, the plan proposed, by restoring the original state of the topography of the country, thereby forcing the surplus waters of the sound to pass directly to sea, aided in the first instance by art, would give a result corresponding to its original state.

5th. That because of the presence of the same causes which gave to the inner navigation at Ocracock so limited a depth, we cannot hope for the creation of an inlet at Roanoke which would better subserve the interests of the upper country, excepting by its directness, than exists at the former place.

6th. That no human foresight can predict the precise result of any operations of a similar character, when the causes to be governed, when known, are so various and powerful; and,

now labors. The general features of his plan are tl
channel through the shoal ground, cutting across the
it and the sea, and, by the intervention of a tide-l
trade an outward navigation between half tide and hi
This plan, it will be perceived, contemplates a cha
only available for outward-bound vessels, and not fo
ward. He estimates the total cost of his project at
estimate was made in 1829, it should, on account of e
present date, be increased at least 100 per cent., or m

PLAN OF WALTER GWYNN, CIVIL ENGIN

Mr. Walter Gwynn, an eminent civil engineer, i
"board of internal improvements for North Carolina
ing of Roanoke Inlet, dated May 27, 1840, discuss
causes which led to the closing of that inlet, and,
who preceded him, attributes it to the gradual enlarg
and Roanoke Sounds, and the corresponding weakne
waters of Albemarle Sound to resist the power of t
silt up the inlet. The plan he proposed is, like Mr.
embankments across Croatan and Roanoke Sounds,
the "banks" to low water. The force of the current
in his judgment, would then be sufficient to open and
nel of adequate depth for the purposes in view. H
make of crib-work, kept in place by piles, the cribs
earth and capped with large flat stones 6 feet abov
and to have slopes of earth on each side, and to be
shore with sloped walls of stone. The total cost of
mates at $937,770, which at present date should be
cent., making estimate $1,641,097.

PLAN OF LIEUTENANT D. P. WOODBU

Under date of February 21, 1853, Lieutenant D. P.
of Engineers, United States Army, submitted to C

He is equally opposed to Fulton's second plan of timber and earth for his embankment, and his reasons are, that the wash from the dashing of the waves would gradually remove the earth and expose the timber to the action of the salt-water worm, and decay from exposure to the weather, and thus the whole fabric be rendered worthless for the object in view.

He is equally opposed to the plan of Captain Bache, of a tide-lock at the inlet. "The scouring power of all the water that can flow out of a tide-lock does not seem sufficient to keep the outlet open. Every flood-tide, and the ebb also, until the gates are opened, will bring a great deal of sand along the beach and leave it in the channel. The overflowing water, if able at first to remove all the sand, will carry it out into deeper water, where a part will be carried away and a part left to accumulate from day to day, and form a bar too distant to be removed by so small a cause, the small current from the lock losing its power by diffusion."

He objects to the plan of Mr. Gwynn, for the reason that the incessant play of the waves between high and low water in every wind and during high winds, the violent action of the breakers caused by the sloping sides, and extending for some distance below low water to the top of the embankment, would derange the stone revetment directly and let it down in places; in others, loosen and remove the mud beneath the revetment. The effect of all this would be eventually to expose the logs and cause them to rot, the result being, in a few years, the demolition of the dam, and the total failure of the project to shut off the waters of Albemarle and Pamlico Sounds.

He then proposes a plan which, if ineffectual, will not exclude dams, which he prefers to be made of concrete. He proposes by excavation and dredging to reopen the inlet about 150 yards wide and 6 feet deep, at the ordinary stage of the water, and at the proper time to run out a jettee of large stones or cubic masses of concrete, resting on grillages of pine logs, on each side of the opening, giving to them and the exposed points the necessary protection. These operations, in his judgment, would give a harbor and channel of entrance for vessels drawing from 12 to 15 feet. He estimates the cost at $500,000, which, adding 75 per cent. on account of enhanced prices, would amount to $875,000.

Captain Woodbury, it would appear, on an appropriation by Congress of $50,000, commenced operations on his plan, and continued the same till the 13th of March, 1856, when Lieutenant W. H. C. Whiting, Corps of Engineers, was assigned to the work. Subsequently to this Lieutenant Whiting, with Brevet Lieutenant Colonel W. Turnbull, Corps of Topographical Engineers, inspected the operations together, and the following was the latter's report on the subject, which is so terse, and, as I think, pertinent in the matter, bating some errors of statement to be hereafter noted, I cannot refrain from extracting nearly the whole of it in his own language. The report was made to Colonel J. J. Abert, Chief of Corps of Topographical Engineers, September 1, 1857:

> The subject of re-opening Roanoke Inlet has been reported upon by several engineers of distinction: first, by Mr. Fulton, an English engineer, employed by the State of North Carolina in 1820; second, by Captain Bache, Topographical Engineers, in 1829; and by Mr. Gwynn, a well-known civil engineer, employed by the State of North Carolina; and fourth, by Lieutenant Woodbury, Corps of Engineers, in 1853; all of whom agree in the necessity of building dams across Croatan Sound, which, according to Lieutenant Woodbury's report, is three miles over and averages 8 feet deep, with a greatest depth of 13 feet; another communication east of Roanoke Island, called Roanoke Sound, with a principal channel one-half mile over and averaging 4 feet

deep, and several smaller channels, about three-fourths of a mile over and 1 in addition to which are the marshes, 18 inches above ordinary level, one quarter miles, making the dam seven miles in length, for which the item alone is estimated by Mr. Fulton at $2,450,000.

Lieutenant Woodbury proposes, first, to excavate a channel 150 yards mencing at 6 feet water in the sand, and continuing in the sand-banks, for estimates $105,500.

He then proposes to cut a canal 900 yards in length, 150 yards wide, and from the sand to the ocean, for which he estimates $40,500; the ocean-end of to be protected by piers of masonry extending, respectively, one-half and of a mile into the sea, the estimate for which is $500,000, which makes $646,000, which added to the estimate of Mr. Fulton for the item of stone $3,196,000, to which must be added other items of material, machinery, gencies, &c., which would, in my opinion, swell the estimate to $5,000,000.

Congress appropriated $50,000 to commence operations; $40,000 have been and at this time there is scarcely a trace to be seen of what has been done, ing sand filling in the trench as fast as it was excavated by the dredging-ma fact, the machine was very near being imbedded in the sand, it filling up behind it, but was gotten out in time to save it.

On my first visit to Nag's Head, in company with Lieutenant Whiting, of the of Engineers, previously in charge of the work, I was perfectly satisfied of the impracticability of the scheme, and, in consequence, reported to the bureau, mending that the work should be abandoned and the machinery and other erty sold, which report was approved by the Hon. Secretary of War, and the was sold on the 15th of August. On reference to the correspondence on this file in the office here, I find that Lieutenant Whiting, of the Corps of Engi viously in charge of the work, a young gentleman of a high order of talent, judgment and discrimination, had frequently reported to his Department, ex "his want of faith in the plan adopted to make a communication between Sound and the ocean, and also his doubts as to its practicability at all, enormous expenditure, altogether disproportionate to the object." In his General Totten, dated March 31, 1857, after referring to the fact of the having filled, he remarks:

> "By referring to my letter to you of September 3, 1856, you will see that the was fully predicted and exposed by me. Never having had any faith at all in the cess of the plan, with the means at hand, these appearances decided me to work until I should hear from you. Any further prosecution with a single boat and the force available, I cannot but consider an unwarranted waste of money."

In regard to the foregoing report of Colonel Turnbull, I would mark that he has fallen into an error representing Captain Wood as reporting the total length of the proposed dams across Croatan Roanoke Sounds as seven miles. The total length, according report, now before me, is six miles. He has erred also in stating Fulton's estimate to have been $2,450,000. It was $2,363,483, and includes dredging the channel and excavating the banks. He has fallen into an error in the details and total amount of Lieutenant W bury's estimate, which should be $500,000, instead of $646,000. He also erred in adding Lieutenant Woodbury's estimate for dredging excavation to Mr. Fulton's estimate for his stone embankment, the ter already including the items of dredging and excavation. The figures, therefore, would be, Fulton's estimate for stone embankment cluding dredging, $2,363,483, plus Woodbury's estimate for piers contingencies, $354,000; total, $2,717,483. But, as I have stated in my judgment the more proper way to arrive at the truth of F estimate of $2,363,483, at the present time, would be to increase least 100 per cent. on account of enhanced values, thus mak $4,726,966, to which should be added, as above, Lieutenant Wood estimate for piers and contingencies, $354,000, plus 75 per cent. creased values, making total probable cost of project, including embankments across Croatan and Roanoke Sounds, dredging of nel, excavating of banks, and piers of inlet, $5,345,966.

The report of Colonel Turnbull, giving as it does the experience

Engineer Department in the preliminary operations of re-opening Roanoke Inlet, should, it appears to me, without any further investigation, satisfy any reasonable mind that the whole project is impracticable. But, having been required by your instructions of July 23 last to make an examination or survey, and report on the subject, I will endeavor to fortify this position by the following considerations:

1st. That while Fulton and Gwynn report the practicability of the project, the board of engineers, to whom was submitted the plan of Fulton, express themselves as exceedingly doubtful on this point. They say, as before quoted, "in regard to the advantages resulting to the State if the design can be proved practicable and of permanent utility, the propriety of its abandonment or of its completion will depend chiefly, as respects the State, on the answer to this question."

2d. Captain Bache remarks, in relation to the feasibility of the plan of damming Croatan and Roanoke Sounds, and dredging out the old inlet, according to Fulton's plan, "that no human foresight can predict the precise result of any operations of a similar character when the causes to be governed when known are so various and powerful;" and again, in relation to the cost, he remarks, "that the enormous amount of the cost of effecting the object, joined with a degree of doubt which hangs about the result of every operation of a similar nature, renders it highly probable it may never be carried into effect." He therefore devises a more economical plan—that of a tide-lock, to admit only of the passage of vessels bound outward, which Captain Woodbury, as I have before stated, believes impracticable for any remunerative purpose; and I cannot but concur in his views.

3d. Captain Woodbury proves that Fulton and Gwynn's plans would be ineffective; and resorted to dredging, with the use of protecting-piers at each end of the cut, as sufficient to open the inlet.

4th. From the report of Colonel Turnbull, above given, we learn that both he and Lieutenant Whiting had no faith in Captain Woodbury's plan, and the history of the operation shows that after Captain Woodbury had cut a trench through the sands on the Albemarle Sound side of the inlet, the two officers named inspected the same soon afterward, and could scarcely find a trace of it; and not only so, but that one of the dredges came near being lost by the sands filling in so rapidly behind it. The consequence was that Colonel Turnbull reported the whole project impracticable, and by direction of the honorable Secretary of War it was abandoned and the machinery and other property sold.

5th. Supposing that Fulton's plan of stone embankments across Croaton and Roanoke Sounds were carried out, with the dredging and pier-work, the cost at present valuations, as stated before, would most probably exceed $5,000,000, an amount of money greatly disproportioned to the advantages gained.

6th. In my tours of inspection of the construction of the new light-house at Cape Hatteras, I have several times crossed Albemarle, Croatan, and Pamlico Sounds, and have also taken soundings at the east end of Albemarle Sound, in Roanoke Sound, on the shoals at the mouth of Roanoke Sound, and in Oregon Inlet, and have also examined the supposed site of Roanoke Inlet, and of Captain Woodbury's cut for the new inlet; and independent of the reasons given under the above five heads of the impracticability of the project, I believe the opening of Oregon Inlet, near the south end of Roanoke Sound, for the first time, September 8, 1846,[*] has so completely changed the topography of that sound (not before adverted to by my predecessors) as to make the impracticability of re-opening Roanoke Inlet still more certain. The effect of the opening of Oregon Inlet has been, as the Coast Survey map shows, to narrow in five years, between 1846 and 1851, when the hydrography was made, the channel of Roanoke Sound, at the point where Fulton's Dam would cross it, from a width of one-half mile, with nine feet water, as reported by him, to a breadth of only one-eighth mile, and 8 feet of water. The reason of this has undoubtedly been on account of the shoaling of the water at the south end of the sound, caused by the meeting of the influx current of the ocean through Oregon Inlet, with the southerly current through Roanoke Sound, this making a shoal, the effect of which has been in a manner to dam up this sound, and thus weaken the current to such a degree as to cause all the sediment which had before came down from Albemarle Sound, and freely passed through Roanoke into Pamlico Sound, to fill up and contract the channel of Roanoke Sound. It has also been undoubtedly due to this cause that the water has shoaled to such a degree as the Coast Survey maps show, at the foot or east end of Albemarle Sound. Now, suppose a channel dredged through these last shoals auxilary to the re-opening of Roanoke Inlet, what would be most undoubtedly the effect after every western gale? Most assuredly the light sands of the shoals would be lifted from their resting places and carried along until they could find a lodgment in the new cut channel, and this operation would so invariably and frequently occur as to very rapidly efface every trace of the cut, just as was the case with the trench made by Captain Woodbury.

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[*] Mr. John B. Etheridge, before referred to as living at Oregon Inlet, informs me that the breach now called Oregon Inlet occured September 8, 1846, and that he was the first man to cross it.

7th. Again, admitting that Congress should appropriate the largest sum estimated for the project, ($5,345,966,) and the work carried on with the utmost dispatch, it is very certain every westerly gale would fill the new-cut channel to such a degree as to make it an ever-recurring necessity to dredge it over again; and it is equally certain that on account of the exposed situation of the channel-piers, making them subject to the severest shocks and washings of the ocean, they, too, would require repairs to such an extent and so often as in all probability never to allow a channel to be of any practical use.

8th. For the above-mentioned reasons I respectfully submit that it would be an unwarrantable waste of the public money to apply it to any such object, and none, in my humble judgment, should be appropriated by Congress for the purpose.

All of which is respectfully submitted.

J. H. SIMPSON,
Colonel Engineers and Bvt. Brig. Gen'l, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

APPENDIX R.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, September 8, 1871.

GENERAL: I have the honor to transmit, herewith, my annual report for the year ending June 30, 1871, for the river and harbor improvements, surveys, &c., in my charge, viz: Delaware Breakwater Harbor; construction of pier at or near Lewes, Delaware; improving harbor

Marcus Hook, Pennsylvania; improvement of Wilmington Harbor, Delaware; repairing the stone piers belonging to the United States in the harbor of New Castle, Delaware; clearing and buoying the channel of the Schuylkill River; Ice Harbor at Reedy Island, Delaware; removal of obstructions of Salem River, New Jersey; improvement of South River, New Jersey; improvement of the north and south branches of the Shrewsbury River, New Jersey; survey of Horseshoe Shoals, Delaware River, Pennsylvania; survey of Chester Harbor, Delaware River, Pennsylvania, and survey of Delaware River between Trenton and Bordentown.

Very respectfully, your obedient servant,

J. D. KURTZ,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

R 1.

DELAWARE BREAKWATER HARBOR.

The completion of this harbor, according to the original project, was reported in last year's annual report. This project was devised more than forty years ago.

It is the case here, as in many other Government works, buildings, and establishments, that the growth of the country has far exceeded the provision made for its probable wants. This harbor is quite too small for the accommodation of the vessels which now resort to it. Its position on the coast-line is admirable for the use it was designed to subserve, that of a harbor of refuge for vessels plying north and south along the Atlantic seaboard. It is situated just half-way from Sandy Hook Bay to the mouth of the Chesapeake, and vessels can enter it with very little deviation from their routes, and resume their voyages again with a minimum loss of time.

It is a national work in the highest sense. While the commerce of Philadelphia and of all the other ports in the Delaware resort to it, a great number of other vessels, coming from and bound to ports outside of the Delaware, avail themselves of it just as freely, and take refuge in it from any stress of weather which makes it prudent for them to seek a harbor for a season.

Last year's report shows that fifteen thousand vessels were recorded as visiting this harbor. Adding those entering and leaving without being noted, twenty or twenty-five thousand may be taken as the number that used the harbor during the year. Its present capacity is determined by the space that is sheltered by the breakwater proper. This is a straight line nearly half a mile long, and it may be taken as the diameter of the half circle behind it, the area of which will represent approximately the sheltered harbor. Northeastwardly of the breakwater is the ice-breaker structure, a quarter of a mile in length, but separated from the breakwater proper by a gap of nearly equal extent, through which the sea rolls in northeastwardly weather without hinderance. If the sea which now rolls through this gap were excluded, the diameter of the sheltered area would be about doubled, and that area would be increased to between three and four fold its present extent. This would add very greatly to the capacity of the harbor.

A succession of careful surveys of the harbor shows plainly that the depth of water it affords has been sensibly and steadily diminish since the great stone mounds which compose the works were form. At the same time the point of Cape Henlopen has advanced to the with remarkable rapidity, the shore having gained in that direction feet in forty-three years, while the vertical deposit of sand has reach feet. These facts exact the greatest caution in devising and exe additional works here, and call for very careful scrutiny of their pos and possible effects upon the harbor. Before the mode of shutting the sea from the gap between the works is decided on, the sub should receive the consideration and study of more than one experien engineer. My opinion is that the safest method is the preferable. There will be opportunity now for a year's observation, by an engi officer on the spot, of the action of sea, waves, currents, winds and the physical and meteorological features of the position, so that reli data, running through the four seasons, may be collected, where s it has been found impracticable to obtain definite particulars that c be relied on.

The three practical methods of enlarging the harbor are as follow

First. Fill the gap between the breakwater and ice-breaker with s uniting the two structures and making the whole a continuous bar to the sea.

Second. Prolong the ice-breaker to the eastward till it laps the brea water sufficiently to exclude the sea.

Third. Construct a detached work in advance of the gap of suffic length to cover it at both ends.

The first method is the cheapest, but it prevents all access to the harbor by the gap, and requires vessels coming down the bay, as w as those going up, to pass to the southern end and enter between Ca Henlopen and the breakwater.

The third method allows access by the gap to vessels entering fr either direction. Moreover, it interferes in the least degree with the currents and tides of the harbor, and so best avoids the risk of inju the depth of water and of disturbing the shore lines.

The first project will require:

112,600 tons of stone, at $4 50 per ton	$506,7
189,000 tons, at $3 50 per ton	661,5
	1,168,2
Add for contingencies 12½ per cent	146,0
Total	1,314,2

The second project will require:

177,300 tons of stone, at $4 50 per ton	$797,8
266,000 tons, at $3 50 per ton	931,0
	1,728,8
Add for contingencies 12½ per cent	216,1
Total	1,944,9

The third project will require:

207,700 tons of stone, at $4 50 per ton	$934, 650
311,500 tons, at $3 50 per ton	1, 090, 250
	2, 024, 900
Add for contingencies 12½ per cent	253, 100
Total	2, 278, 000
The existing works have cost	$2, 127, 403

A plan of the harbor, with sketches of the three projects here indicated, is transmitted with this report. This subject is fully discussed in the reports of Major Hartman Bache, Corps of Topographical Engineers, dated 15th October, 1844, 16th September, 1839, and others.

The views which I have presented are in accordance with those entertained by that officer.

STATEMENT OF FUNDS.

In hands of officer June 30, 1871	$1, 711 93
In Treasury June 30, 1871	1, 961 17
Total on hand	3, 673 10

It is recommended that there be appropriated for the service of the fiscal year ending June 30, 1873, for increasing the capacity of the Delaware Breakwater Harbor, or for continuation of operations at the Delaware Breakwater Harbor, $300,000.

R 2.

CONSTRUCTION OF PIER AT OR NEAR LEWES, DELAWARE.

The appropriation for the construction of a landing-pier at the Delaware Breakwater Harbor, was made at the close of the session of Congress in the summer of 1870. Ever since the construction of this breakwater, by which an important artificial harbor of refuge was constituted at the mouth of the Delaware Bay, it has been very desirable for vessels using the harbor that convenient means of communicating with the shore should be provided for their use. A boat-pier was first constructed by the United States, and since its decay Congress has several times called for information as to the best means of replacing it. Recently a railroad has been constructed connecting the harbor with the region in its rear and with the general railroad system of the country. At the session of 1870–'71 an appropriation of $225,000 was made for the construction of a landing-pier of stone or iron at this locality. After the collection of all practicable information on the subject a project for a pier on wrought-iron screw-piles was submitted to the Chief of Engineers, and the proposed structure was approved by him, with the concurrence of a board of engineer officers in the project. Further information was desired by the board before deciding upon the position for the p This information has been obtained, and the question of site may sh be passed upon by it. In the mean time, such other measures practicable have been taken to expedite the work.

Arrangements have been effected for procuring the materials for the work; experiments on the soil, and the means of penetrati have been made; measures for securing a site from the Sta Delaware have been effected, and such steps as will facilita determination of the legal questions concerned are in progress. the transfer to the United States of the site for the shore-end pier, and the approval, by the Attorney General of the United St of the action of the State of Delaware in the matter, the constr can be commenced. Abstracts of proposals for the iron and lumb this pier are transmitted herewith.

To complete the structure the sum of $55,000 will be required. is asked that this sum be appropriated for the service of the next year.

STATEMENT OF FUNDS.

Appropriation by act of July 11, 1870	$225,0
Expenditures, (surveys, plans, services, &c.)	3,9
Balance available July 1, 1871	221,0
Appropriation asked for year ending June 30, 1873	$55,00

Abstract of proposals for iron for pier at Lewes, Delaware.

Number.	Name of bidder.	MATERIALS.			Remarks.
		1st-class—rolled iron, 56,920 lbs.	2d-class—wrought and hammered iron, 532,019 lbs.	3d-class—cast iron, 143,000 lbs.	
1	Catasauqua Manufacturing Company, Catasauqua, Pennsylvania	$1,992 20	....	....	Prices at their w
2	Albright & Shote, Mauch Chunk, Pennsylvania	5,692 00 5,862 76	....	$8,634 00 9,065 70	Do. Delivered at Lew
3	Paulding, Kemble & Co., West Point Foundery, Cold Spring, New York	5,549 71 5,663 55	$42,652 24 43,716 28	8,993 75 9,221 55	Prices at their w Delivered at Lew
4	M. B. Stotsenburg & Co., Wilmington, Delaware	5,752 25 5,821 98	51,068 37 51,720 09	7,676 25 7,852 63	Prices at their w Delivered at Lew
5	Paterson Iron Company, Paterson, New Jersey	3,597 00 3,681 60	42,341 09 45,001 09	....	Prices at their w Delivered at Lew
6	Kellogg Bridge Company, Buffalo, New York	4,322 84	46,117 07	8,058 40	Do.
7	I. P Morris & Co., Philadelphia, Pennsylvania	5,407 39	39,278 24	7 914 50	Prices at their w

Abstract of proposals—lumber for pier near Lewes, Delaware.

No.	Name of bidder.	White pine.	Yellow pine.
1	S. B. Garrison & Co., Camden, New Jersey	$15, 944 00	....
2	J. Bigler & Co., Newburgh, Orange County, New York	15, 744 70	$16, 416 05
3	Bigler & Son, Harrisburgh, Pennsylvania	15, 146 80	....
4	Shartznen & Bruner, Columbia, Pennsylvania	13, 544 08	....
5	William M. Shakespeare, Dover, Delaware	17, 419 60	16, 416 00
6	Heikel & Harris, Dauphin, Pennsylvania	13, 570 65	....
7	R. J. & W. Neely & Co., Portsmouth, Virginia	....	13, 570 90
8	Cook & Pardee, Watsonstown, Pennsylvania	15, 585 80	....
9	S. B. Garrison & Co., Camden, New Jersey	....	18, 445 00
10	Watson & Pittinger, Brooklyn, New York	15, 545 40	14, 387 10
11	Eppinger, Russell & Co., New York City	....	16, 600 50

R 3.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pa., April 5, 1871.

GENERAL: I have the honor to report as follows, upon the subject of the construction of "a good and substantial pier of stone or iron in the Delaware Bay, at or near Lewes, as provided for in section 12 of the act of July 15, 1870, (public, No. 183,) making appropriations for sundry civil expenses," and to submit the accompanying project for the construction of a pier, in compliance with your instructions of July 28, 1870, placing this matter in my charge.

As soon as the artificial harbor the of Delaware Breakwater came into use by vessels, the want of a landing-pier to enable them to communicate with the shore was realized; and provision was thereupon made by Congress for such a pier, to enable boats to land, provisions and supplies to be obtained, and to give access to the lines of travel and afford mail accommodations.

Accordingly, in 1837, a wooden-pile landing-pier was constructed by General (then Captain) R. Delafield, of the Corps of Engineers, for these purposes. This pier was about 1,200 feet long, with a uniform width of 20 feet, and had 8 feet of water at the pier-head at low water. The bays of the pier were 19 feet wide, with four rows of piles between them. The structure was guarded by a series of six ice-breaker piers on the seaward side, and a like series on the inner side, these piers being placed at distances of 75 feet from the landing-pier, and 100 feet to 150 feet from one ice-breaker to the next. This structure cost about $60,000, and lasted eleven or twelve years. It was not injured by the ice. A vessel adrift once broke through it, after the piles had been honeycombed by the boring-worms, which were the cause of its failing after twelve years' service.

In 1859 Lieutenant Colonel (then Captain) John Newton, Corps of Engineers, in compliance with instructions from the Chief of Engineers, presented a project for a landing-pier at the harbor. He proposed a wharf 90 feet by 90 feet, supported on 16 stone piles, to be connected with the shore by the shortest line, about north and south, the distance being a little over a thousand feet. The connection was to be a wooden trussed bridge 14 feet wide, with bays of a hundred feet, to be supported upon two sets of stone piers. Depth of water at the pier head 9 feet at low water. The stone piers to rest upon iron screw-piles. Colonel Newton presented his project as an illustration of the general principles upon which such a structure should be erected. The estimate of this project was $88,000.

In 1864 the Senate, by resolution of February 3, directed its committee on Commerce "to inquire into the expediency or necessity [illegible] constructing a pier near, or opposite to, the town of Lewes, in the State of Delaware, for the protection of vessels navigating the Delaware Bay and River." Under this resolution Lieutenant Colonel Henry Brewerton, and Captain F. E. Prime, Corps of Engineers, were constituted [illegible] board of engineers, and instructed to examine the questions presented, and to report a plan of piers with estimates, for structures of stone [illegible] of iron. In their report they state, respecting the necessity and [illegible] of a pier:

The large number of vessels that seek for shelter at the harbor; the supplies they need; vessels calling for orders; the necessity [illegible] means of communicating with the shore and with Philadelphia; [illegible] difficulty of crossing the bar which lies off the beach about [illegible] and the ice that forms along the shores, too compact for boats to penetrate, yet not strong enough to pass over conveniently.

They propose a pier reaching to 9 feet at low water, and requiring a length of about 1,200 feet. The location, the same as that chosen [illegible] Captain Newton, a short distance nearer the cape than the spot occupied by the former Government wooden pier.

Their project for pier, with stone substructure, proposed to rest [illegible] pier-head on three rows of stone piers, 4 feet by 4 feet, twelve in [illegible] 20 feet from center to center; the area to be 64 feet by 44 feet; [illegible] stone piers to be supported by screw-piles penetrating the soil to [illegible] depth of 8 feet; floor timbers of 12 inches by 12 inches, placed on [illegible] piers, to cross each other and sustain the floor of 3-inch planks; [illegible] whole well tied together with iron; the piers of the bridge from [illegible] shore to be 10 feet by 4 feet; the bridge to be 14 feet wide, and its p[illegible] 22 feet from center to center, and supported on screw-piles; top [illegible] like the pier-head.

They prefer a pier to be obtained by hollow tubular beams of [illegible] iron resting on piers, 40 to 50 feet apart; the pier-head to rest on [illegible] iron piles, 4 to 6 feet diameter, sunk by atmospheric pressure, and [illegible] with concrete. The estimated cost of pier, built on stone substructure, is $147,000.

For an iron pier they propose screw-piles, $6\frac{1}{2}$ inches in diameter, braced by 3-inch bars, and screws of 3 feet diameter for the substructure; the top work to be of timber similar to the stone-pier [illegible] Their estimate for pier on screw-piles is $114,000.

On the 4th February, 1869, the House of Representatives called [illegible] the Secretary of the Treasury to communicate to the House all [illegible] information in his possession relating to surveys made in the Delaware Breakwater Harbor, with a view to the erection of a pier.

Upon this call the survey of Lieutenant Frank Barr, of the revenue service, was forwarded to the Speaker of the House, and also, from [illegible] War Department, the report of Colonel Brewerton and Captain Prime, of which an outline is given above.

Lieutenant Barr states the large number of vessels that seek [illegible] harbor for refuge, its advantageous situation, the necessity for additional protection, and for facilities for communicating with the shore.

The main deficiencies of the harbor are, he states: 1st. Insufficient capacity. 2d. Inadequate protection. 3d. Insufficient depth of [illegible] 4th. Want of protection against ice. 5th. Difficulty of landing [illegible] obtaining supplies. He indicates four points in the harbor where [illegible] depth of 15 feet at low water can be had, and recommends a wharf [illegible] iron piles at the most suitable place.

Within comparatively a few years the peninsula of Delaware has been traversed from north to south by a trunk railroad, and a large number of lateral roads have been constructed, connecting the main trunk, at various points, with the Delaware and Chesapeake Bays. One of these connecting roads, the Junction and Breakwater Railroad, has recently been completed to the shore of the Breakwater Harbor, so that the harbor is now in connection with the railroad system of the country. It was indispensable that a suitable landing-pier should enable vessels to receive and discharge cargoes from the railroad, and the company have accordingly constructed, at a cost of $37,000, a pile-pier 1,600 feet long, with the requisite track room and shipping facilities at the terminus of their road. This landing-pier has 14 feet water at its head at low water. It was completed in the early part of the summer of 1870. During the busy season of 1870, a steamer of 1,200 tons burden made constant trips to New York, carrying the freight from the line of the railroad, and also passengers and the return freight from New York.

Congress by the twelfth and thirteenth sections of the act of July 15, 1870, (public, No. 183,) appropriated the sum of $225,000, or so much thereof as may be necessary, to construct a good and substantial pier of stone or iron in the Delaware Bay, at or near Lewes, and provided that the Junction and Breakwater Railroad may extend their railroad upon and over said pier, and freely use said pier in connection with their road, subject to such regulations and charges for maintenance and repairs as the Secretary of War may adopt.

The first question to be determined respecting the construction of this pier is the position it should occupy in the harbor. This depends upon the draught of water that it is to afford, and the class of vessels that will make use of it. The first pier, built in 1837, extended into 9 feet water, and was designed to enable vessels to communicate with the shore by means of their boats. The railroad pier just finished has 14 feet water at its head, and afforded a shipping place during the last summer to a large steamship.

I consider that the pier now appropriated for by the United States is intended to afford all necessary facilities to all vessels seeking the protection or use of the harbor of refuge at this breakwater, and that with the means of transportation to the harbor supplied by the railroad just completed, all kinds of supplies and means of refitment may be provided at this place, and especially that coal for fuel for sea-going steamers may be put in depot for that use. Heretofore this has not been practicable. Steamers in want of fuel have occasionally come into the harbor, and I believe have used such coal as has been collected from vessels wrecked in the vicinity. It is not supposed that the use of a pier for such purposes will grow up suddenly, but rather that it will gradually be availed of, as its value comes to be realized. The naval steamers of the Government, as well as merchant vessels, should be able to use the pier for supplies. The existing pier is, no doubt, sufficient for present purposes, and will be serviceable for a number of years.

Following these considerations, I am of opinion that the pier should be so located that it will be practicable by additions, if necessary to its length, to reach as deep water as the harbor affords, or as may be required by any vessels resorting to it for refitment or supplies. Five positions for the pier are marked on the chart of the harbor accompanying this report. The first will afford 16 feet water, with a length of 1,560 feet; the second 17 to 18 feet, with a length of 1,680 feet; the third 19 to 20 feet, with a length of 1,680 feet; the fourth 21 to 22 feet,

selection is to be made for the structure. A pier-head
small dimensions, isolated at the end of a long conn
liable to receive the severest pressure of ice-fields and
to be exposed to the accumulated force of large ves
side and riding against it with the roll of a moderate
lars of moderate dimensions, built in horizontal cou
upon a substructure of iron or other material, are liable
by such an enormous mass in motion, while the cross d
stone-work are still so large and the interspaces so sn
that floating ice will not pass through, but will accumu
pier-head and form fields of large extent. For these
narrow pier-head is proposed, and iron is preferred as
the pier, in piles having no joint or horizontal plane of
top to bottom, the lines of piles to be placed at short
and the whole structure to be bound together by ties a
to receive the pressure of vessels and of ice at a large n
and distribute it through as many members as possible.
this general arrangement a series of pile fenders is
placed along the outer part of the structure, connected
izontal ties, but entirely disconnected from the memb
proper. This entire system will have to yield the dist
and the pier (taken at 2 feet) before any pressure will
latter. A series of mooring and winding buoys will b
sides of the wharf, to which vessels lying alongside wil
as to relieve the fenders of most of the pressure that m
them. Vessels can always lie alongside in moderat
when ice forms it will be resisted, bodily, by the who
structure in to its shore end, the pressure being gradu
the ice takes the bottom. No attempt is made to pro
sage of floating ice between the lines of piles. It is be
would not be practicable, even with bays of 50 or 100 fe
wind would set the floating ice against the frame work
and the wider the bays (within such limits as are
greater the mass that would press against each indivi
fields of ice are a more serious difficulty. These

This arrangement would at the same time give incidental protection to the landing-pier. Such a series of works is suggested by Lieutenant Barr in his report mentioned above.

If observation should show that special ice-breakers must be used for protection of the pier, they will probably be required to be placed at such positions as are indicated on the chart herewith by the letters *i*, *i*, *i*.

The position for the pier, having the deepest water, as indicated above, is necessarily more exposed to the action of the sea than those lying farther up the harbor where the water is shoaler. This would be cause of anxiety if experience had not shown more satisfactorily than is the case with respect to ice, that no apprehension need be felt of injury being done to the structure by the force of the waves. In 1847 Alexander Mitchell, the originator of the iron screw-pile, was led to apply his invention to the construction of a landing-pier at Courtown, on the southeast coast of Ireland. An open sea of seventy miles in front beats on the shore at the point selected for the work. It has stood without injury, and has shown that there need be no hesitation in applying his method in the heaviest sea-way.

An examination of the chart of the harbor herewith will show that the general effect of the breakwater structure has been to shoal the water through the harbor.

A special shoal has been formed just within the northwest end of the main work, while deep excavations of the bottom have been produced where the confined waters pass near the works through the contracted water-ways.. In general, the lines of deep water have moved eastwardly toward the lower end of the harbor. At the same time a very remarkable action has taken place along the eastern beach toward the point of the cape. It might have been expected that the ebb-current, directed southeastwardly along the line of the breakwater, would have swept over to the beach and washed it away pretty freely. Instead of this, however, this beach has made out extensively, so that the point-beacon was advanced, in 1864, to a position 833 feet north of where it stood since 1789, and there are now 400 feet of beach in advance of this building.

The comparative lines of 1828 and 1870 show that a large strip of beach has probably been swept away on the ocean shore, abreast of the cape light, and a like strip been added within the cape, from east to west. This sort of action is going on elsewhere, under the influence of natural causes; but the interposition of a great artificial obstacle like the stone mound of the breakwater would seem to be sufficient to have produced a modification of the action at least. These disturbing causes are at work along the beach where any site of a landing-pier must be fixed, and it is necessary to give some weight to the probability, greater or less, that the sand may be swept away hereafter by the operation of a compensating or oscillatory phase of the action. The profiles along the several sites proposed for the pier show the extent of the changes from time to time. It is proposed to carry the piles down, if it be practicable, below the lowest level of the bottom shown by the surveys.

The fact that the bottom is sand, without cohesion, and everywhere moving under the influence of the currents of the harbor, is a forcible reason for using piles of the smallest cross-section, (wrought iron,) instead of stone, for the supports of the structure. Stone would require supports of considerable area, and these would either accumulate the sand so as to increase the shoaling of the water, or they would act as material obstacles, and quicken the currents to the danger of their foundations being undermined and cut away. Probably both results breakwater and the ice-breaker. This step will make space three or four times as large as it now is.

There are three ways of closing this gap:

First. To extend the ice-breaker eastwardly till it laps to exclude effectually the heavy seas which now come in winds, the extension to be curved gradually inwards t about parallel to the main work.

Second. To place a third structure outside the gap, at tance, and of length enough to shut out the sea.

Third. To prolong the west end of the breakwater til ice breaker. This last method would prevent all access the gap, and require the harbor to be entered between tl and the beach of Cape Henlopen. The first method wo gap open to vessels, but make it of inconvenient access to down the bay. The second method would leave two op use of vessels, and would disturb the currents the least this reason I prefer it. In view of the great and unlik currents which the chart shows to have taken place, extrem be taken to do nothing the results of which cannot be the one hand, a forced diversion of the water may swe structure placed along the beach. On the other, the sup existing channel-way may greatly increase the shoaling acti on, and result in the ruin, practically, of this great artificia

The description of the project, which will now be specially to a pier along the line E E^1, but it is applicab modification, to any of the five positions marked in the ch

The earthen approach will reach the work at high-water this the structure extends out 1,800 feet to a depth of 2 water. The bridge connecting the pier-head with the sl wide, with a length of 1,200 feet. Thence it widens, in 1 feet, the width of the pier-head. The pier-head is 500 fe The floor-level is taken at 13 feet above the low-water line.

The bridge is supported by lines of wrought-iron screw apart, with three piles in each row. The pier-head has row, the intervals being 21 feet, like those of the bridge. and the pile-shafts are 5 inches in diamet at 1,470 feet from the shore, and extends out to the outer end of the structure. These are placed below the water level, and are connected with the collars mentioned above, and with another set near the level of the bottom. These braces are placed under water, to avoid obstructing the bays of the pier, or affording a resting-place for ice to form upon or lodge against. Their size is from 2¼ to 3 inches diameter.

The caps on the shaft-head are cast with seats to receive the longitudinal girders that carry the superstructure. Timber girders, 12 by 14 inches, rest on these, and extend the entire length of the structure. These are crossed by beams 9 by 10 inches, by which the whole structure is stiffly united together. The cross-beams and girders are bolted together by bolts, which also pass through the metal seats and attach the wooden frames to the pile-heads. Between the cross-beams, floor-joists, 9 by 4 inches, are placed to carry the road-ways. Half the floor is fitted with string-pieces, 8 by 12 inches, for railway tracks, and half with a plank covering for the use of ordinary wagons.

The outer part of the pier is protected against the pressure of vessels and of ice by a system of fenders, formed as follows: At the ends of each line of piles and 2 feet from the pier, two piles, 5 inches in diameter, with screws of 2 feet diameter, are inserted into the bottom, a little obliquely, and their heads brought together at the level of the floor. These are united by clamps, to which are attached 2-inch longitudinal tie-rods that connect the fenders to one another. At intervals of five bays, a fender of three piles is formed, to which a mooring-ring is fastened for the use of vessels.

Opposite the pier-head, on each side, a series of mooring and winding buoys is placed at convenient distances from the pier and from each other, for vessels to make fast to on their off sides. The use of these buoys will prevent the pressure of vessels lying at the pier from coming against the work.

It is considered that the works, as now described, will meet the requirements of the law, and answer a good purpose. A design for superstructure of iron is, however, also supplied for comparison with the wooden one.

The substructure is the same as for a timber top, except that a series of horizontal diagonal ties are now introduced under the floor. The wooden structure is stiff, and is not expected to require this provision, though the pile-caps will be provided with lugs, to which such ties may be attached, if experience should show their employment to be advisable.

Wood being without sensible expansion from increase of temperature, the main timber-girders are designed to be continuous string-pieces from end to end of the pier, and they are rigidly bolted to the cross-beams and to the pile-caps. But if iron top-work be used, the girders must have an open through-joint over each pile to provide for expansion and contraction of the metal, and the bolt-holes, by which the girders are secured to the chairs, must be oblong, and the bolt fitted loosely. On this account the horizontal ties are introduced into this project. It will be observed, also, that the under-water longitudinal diagonal ties are not proposed for the inner end of the pier. It is considered that the rigidness of a timber top will allow of their being dispensed with in shallow water. But with an iron superstructure they could not so safely be neglected.

The pier with a wooden top is regarded as the preferable project, and it is materially the cheaper, viz, by about $49,000.

The coefficient of security has been taken at 5 throughout the calculations. The work is designed to carry with safety a full train of heavy locomotives on each track. With a 15-inch gun on each rail-track on each bay, the coefficient will be 4.3+. With a 20-inch gun it would be

2.15+ ; but this last weight should be placed only on a burden-car, and not upon the floor.

The inshore piles which are not braced with longitudinal under-water ties will be prepared with necks, so that in the event of the beach getting out, collars and braces may be applied to them.

The work should be executed by successive steps, beginning at the shore end and advancing bay by bay to the outer end. The accuracy of the dimensions, and their being fixed beforehand within narrow limits requires this. In this way the structure will serve, too, as its own staging for the greater part. This determines the rate of progress of its construction.

In light-house work from two to seventeen hours are required to set a pile, after it has been adjusted over its place. In pier-work two or three piles a day is an average day's work. Many of the piles in the present project being of large dimensions and weight, it is estimated that the shore-end may be executed at the rate of three piles per day, and the outer end at the rate of two piles per day. Two hundred and fifty piles, at three per day, gives eighty-three and one-third days. Two hundred and fifty-four, at two per day, gives one hundred and twenty-seven days; together, two hundred and ten working-days. Add for non-working days, two-fifths, or eighty-four days, the total is two hundred and ninety-four days' time, being from nine to ten months.

This is the greater part of two working-seasons, which time the work will probably require.

The materials can be procured from the manufacturers of iron and the dealers in lumber, by contract, with due provision for inspection of them while in preparation.

It is recommended that the workmanship be by days' labor, [illegible] careful and intelligent supervision. The work is novel in its character, and of a kind of which little is known in this country by the class of persons undertaking contract-work. It will be to some extent tentative in the process employed, and will require exactness of adjustment of parts and careful check of errors at their beginning. Experience has shown that the contract method is not advantageous in several [illegible] work, and leads to the conclusion that it should not be employed in such work as that now under discussion.

The principal recommendations of this report are the following:

1st. That the pier be placed at the position marked in the chart by the letters E E^1.

2d. That the material be wrought iron.

3d. That the superstructure be of wood.

4th. That materials may be procured by contract.

5th. That the workmanship should be executed by days' labor.

An estimate of the cost of the work is transmitted with the report. It is believed that the amount of the estimate will construct the pier of the dimensions and in the position proposed.

Four sheets of drawings illustrating the project are transmitted by express, as follows:

1st. Plan and sections Delaware Breakwater Harbor.

2d. Plan and elevation of proposed iron landing-pier.

3d. Plan and section of outer end of pier-head.

4th. Ditto, ditto. (Iron superstructure.)

Respectfully submitted.

J. D. KURTZ
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Estimate of probable cost of an iron landing-pier at the harbor of the Delaware Breakwater.

	Designation.	Price.	Cost.
MATERIALS OF SUBSTRUCTURE OF PIER.			
45 piles, 45 feet by 8 inches, (45 by 45 by 167.5) ....pounds..	339, 187		
25 piles, 40 feet by 7½ inches, (25 by 40 by 142.65) ....do....	142, 650		
30 piles, 35 feet by 6¾ inches, (30 by 35 by 123.7) ....do....	129, 885		
25 piles, 30 feet by 6¼ inches, (25 by 30 by 98.2) ....do....	73, 650		
76 piles, 25 feet by 5¾ inches, (76 by 25 by 82.83) ....do....	157, 377		
111 piles, 22 feet by 5¼ inches, (111 by 22 by 68.76) ....do....	167, 912		
312	1, 010, 661	$0 7½	$75, 799 58
80 long'l braces, 28 feet by 3 inches, (80 by 28 by 23.56)..pounds..	52, 724		
50 long'l braces, 25 feet by 2¾ inches, (50 by 25 by 19.8).....do....	24, 750		
60 long'l braces, 22 feet by 2½ inches, (60 by 22 by 16.36)....do....	21, 595		
50 long'l braces, 22 feet by 2¼ inches, (50 by 22 by 13.25)....do....	14, 575		
72 cross-braces, 14½ feet by 2½ inches, (72 by 14.5 by 16.36)..do....	17, 090		
40 cross-braces, 14½ feet by 2⅜ inches, (40 by 14.5 by 14.76)..do....	8, 560		
48 cross-braces, 14½ feet by 2¼ inches, (48 by 14.5 by 13.25)..do....	9, 222		
40 cross-braces, 14½ feet by 2⅛ inches, (40 by 14.5 by 11.82)..do....	6, 855		
252 cross-braces, 14½ feet by 2 inches, (252 by 14.5 by 10.47)..do....	38, 256		
692	193, 627	10	19, 362 70
692 screw-buckles, average 60 pounds each ....pounds..	41, 520	25	10, 380 00
1,384 bolts and nuts, average 10 pounds each ....do....	13, 840	12½	1, 730 00
624 collars for braces, average 200 pounds each ....do....	124, 800	11	13, 728 00
312 cast-iron screws, 2 ft. 6 in. diam., average 350 pounds.....do....	109, 200	5	5, 460 00
312 cast-iron caps, 525 pounds each ....do....	163, 800	5½	9, 009 00
WORKMANSHIP OF SUPERSTRUCTURE OF PIER.			
Receiving and putting down 312 piles ....days..	5, 400	1 75	9, 450 00
Blacksmith's labor ....do...	570	3 00	1, 710 00
Adjusting caps and braces, smithery ....do...	350	3 00	1, 050 00
Adjusting caps and braces, labor ....do...	450	1 75	787 50
Services of divers ....do...	....	....	2, 000 00
MATERIALS OF SUPERSTRUCTURE OF PIER.			
9,570 lineal feet string-timbers, 12 by 14 inches..........M b. m..	134	40 00	5, 360 00
30,000 lineal feet cross-timbers, 9 by 4 inches ....do....	90	40 00	3, 600 00
5,046 lineal feet cross-timbers, 9 by 10 inches ....do....	38	40 00	1, 520 00
4,600 lineal feet railroad-stringers, 8 by 12 inches ....do....	37	40 00	1, 480 00
1,300 feet length by 10 feet planking, 13,000 } 500 feet length by 20 feet planking, 10,000 } 23,000 by 4 in...do....	72	40 00	2, 880 00
Planking between railroad-tracks ....do....	38	40 00	1, 520 00
3,600 lineal feet white-oak rail, 6 by 4 inches ....do....	7	45 00	315 00
1,248 bolts through string-timber, 5.22 pounds ....pounds..	6, 514	12½	814 25
Other bolts and spikes ....do....	3, 000	12½	375 00
4,600 lineal feet rails, (20 pounds per foot) ....do....	92, 000	5	4, 600 00
WORKMANSHIP OF SUPERSTRUCTURE.			
Constructing timber top, carpentery ....days..	1, 000	3 00	3, 000 00
Constructing timber top, labor ....do...	700	1 75	1, 225 00
MATERIALS OF FENDERS.			
42 piles, 47 feet by 5 inches, 1,974 } 22 piles, 42 feet by 5 inches, 924 } 3,860 lin. ft. by 65.45 ..pounds.. 26 piles, 37 feet by 5 inches, 962 }	252, 637	7½	18, 947 78
MATERIALS OF FENDER SYSTEM.			
22 piles, 30 feet by 5 inches, 660 80 piles, 25 feet by 5 inches, 2,000 102 ——— 2,660 by 65.45 ....pounds..	174, 097	7½	13, 057 27
75 fender caps, 73 pounds each ....pounds..	5, 475	11	602 25
14 fender caps and rings, 105 pounds each ....do....	1, 470	10	147 00
1,760 lineal feet braces, 2 inches diameter, (10.47) ....do ...	18, 427	10	1, 842 70
88 screw-buckles, 50 pounds each ....do....	4, 400	25	1, 100 00
176 bolts and nuts, 6 pounds each ....do....	1, 056	12½	132 00
192 cast-iron screws, 2 feet diameter ....do....	57, 600	5	2, 880 00
WORKMANSHIP OF FENDER SYSTEM.			
Receiving and putting down 192 piles ....days..	2, 100	1 75	3, 675 00
Blacksmith's labor ....do...	230	3 00	690 00
Adjusting collar and braces, (smithery) ....do...	50	3 00	150 00
Adjusting collar and braces, (labor) ....do...	150	1 75	262 50

Cost of an iron landing-pier at the harbor of the Delaware Breakwater—Continued.

	Designation.	Price.	Cost.
BUOYS.			
12 chains, bars, swivels, and schacles ..... pounds..	10, 800	$0 12½	$1, 350 00
12 screws, 2 feet diameter, 300 pounds each ..... do....	3, 600	5	180 00
12 buoys	.....	50 00	600 00
MACHINERY AND APPARATUS.			
Workshops and storehouses	.....	.....	1, 000 00
Scow with pile-driver	.....	.....	1, 800 00
Portable engine	.....	.....	1, 500 00
2 boats	.....	.....	350 00
Temporary landing	.....	.....	3, 000 00
Cordage, tools, &c	.....	.....	1, 000 00
Labor in care of and repair of machinery ..... days..	2, 000	1 75	3, 500 00
CONTINGENT AND UNFORESEEN EXPENSES.			
Superintendent ..... months..	24	1 50	3, 600 00
Overseer ..... do....	24	1 20	2, 880 00
Clerk ..... do....	24	1 20	2, 880 00
Draughtsman ..... do....	24	1 20	2, 880 00
Inspector ..... do....	12	1 50	1, 800 00
Surveys, soundings, &c	.....	.....	2, 000 00
Stationery, office-rent, fuel, transportation, freight, postage, &c ..	.....	.....	2, 150 00
Total	.....	.....	253, 112 53
Add for unforeseen expenses	.....	.....	25, 311 25
Total estimated cost of work	.....	.....	278, 423 78
ESTIMATED COST OF IRON SUPERSTRUCTURE.			
6,200 lineal feet horizontal braces, 2 in. diam., (10.47) .... pounds..	64, 914	10	6, 491 40
225 screw-buckles, (50) ..... do....	11, 250	25	2, 812 50
450 bolts and nuts, (6) ..... do....	2, 700	12½	337 50
9,570 lineal feet 15-inch beams ..... do....	638, 000	5½	35, 090 00
24,750 lineal feet 6-inch beams ..... do....	330, 000	5	16, 500 00
9,900 brackets, with bolts, 5 pounds each ..... do....	49, 500	10	4, 950 00
556 separators	.....	.....	646 35
2,300 bolts and plates for railroad-stringers, (2.6) ..... do....	5, 980	12½	747 50
2,496 bolts to fasten beams to caps, (1.25) ..... do....	3, 120	12½	390 00
Total net estimated cost of iron superstructure	.....	.....	67, 965 25
Deduct net estimated cost of wooden superstructure	.....	.....	22, 689 25
Net difference of cost of iron and wooden superstructure	.....	.....	45, 276 00
Add, for unforeseen expenses	.....	.....	4, 527 60
Total estimated difference of cost of iron superstructure	.....	.....	49, 803 60
Total estimated cost of work with wooden superstructure	.....	.....	278, 423 78
Total estimated cost of work with iron superstructure	.....	.....	328, 227 38

R 4.

Proceedings of a board of engineer officers, convened at Philadelphia, Pennsylvania, by virtue of the following order:

[Special Orders No. 42—Extract.]

HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., April 10, 1871.

* * * * * * *

3. A board of engineer officers, to consist of Lieutenant Colonel I. C. Woodruff, Lieutenant Colonel John Newton, Lieutenant Colonel J. D. Kurtz, with First Lieutenant M. R. Brown as recorder, will assemble in Philadelphia, Pennsylvania, on the 18th instant, or as soon thereafter as practicable, to consider and report upon the plan submitted by

Lieutenant Colonel Kurtz April 5, 1871, for a pier at Lewes, Delaware, its proper location, and mode of construction.

* * * * * * *

By command of Brigadier General Humphreys.

THOS. LINCOLN CASEY,
Major of Engineers.

UNITED STATES ENGINEER OFFICE,
1330 *Chestnut Street*, *Philadelphia*, *Pennsylvania*, *April* 18, 1871.

The board met pursuant to the above order at 10 a. m.; present, all the members.

Sections 12 and 13, of the act of Congress of July 15, 1870, "making appropriations for sundry civil expenses," were read, and the board proceeded to the consideration of the project submitted to the Chief of Engineers by Lieutenant Colonel Kurtz, Corps of Engineers, bearing date April 5, 1871, for the pier at Lewes, Delaware, provided for in the above-designated sections.

Mr. J. S. Gibbons, president of the Junction and Breakwater Railroad Company, was present during the reading and discussion of the project, and afterward gave his own views concerning the best location of the pier, stating that he would shortly present his opinions on this subject more formally and in writing, for the consideration of the board.

A copy of a letter from Mr. Gibbons to the Chief of Engineers is herewith submitted as part of the record:

NEW YORK, *April* 13, 1871.

DEAR SIR: I learned from Lieutenant Colonel J. D. Kurtz, yesterday, in Philadelphia, that a board of officers would meet in that city on Tuesday next, the 18th instant, to examine his charts on the survey of the harbor of the Delaware Breakwater, in pursuance of the plan of constructing the pier, &c.

As president of the Junction and Breakwater Railroad Company, which, as provided by law, has the right to occupy the said pier with its tracks, I respectfully ask you that I may have the opportunity of presenting to the board some considerations with respect to the location of the pier in connection with the road. I would like also to be accompanied by one or two of the residents of Lewes, who have long been familiar with the shores and currents of the harbor. I presume that the board will or may get some valuable hints from such persons.

If you have no objection to my proposition, I beg that you will address me a note signifying as much, at Lewes, Delaware, care of Jas. A. Chase, superintendent Junction and Breakwater Railroad.

Very respectfully,

J. S. GIBBONS,
President of Junction and Breakwater Railroad Company.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

His letter bore the following endorsement from the Chief of Engineers:

OFFICE CHIEF OF ENGINEERS,
Washington, D. C., April 14, 1871.

Respectfully referred to Colonel I. C. Woodruff, Corps of Engineers.

No objection exists here to the board of engineers inviting any one interested in the subject to appear before them and present his views.

By command of General Humphreys.

J. B. WHEELER,
Major of Engineers.

The board adjourned at 5.45 p. m., to meet at 9 a. m. to-morrow.

The board met pursuant to adjournment.

The board proceeded to the further discussion of the project, and, after mature deliberations, arrived at the following conclusions:

First.—The pier at Lewes should be adapted to the probable wants of the Government and to the general convenience of commerce; and the arrangement thereof should permit the extension upon it of railroad tracks, and its use by the Junction and Breakwater Railroad Company.

Second.—The project submitted for the consideration of the board presents a structure conforming in every feature to the requirements of the act of Congress of "a good and substantial pier." The iron screw-pile foundation is peculiarly suited to the locality of the capes of the Delaware, where the shifting character of the bottom would be likely to threaten the stability of a more solid structure, if expensive precautions were not taken against such action.

Third.—The position of the pier is well selected, having in view the present and prospective wants of commerce; but it opens the question of an extension of the breakwater towards the cape, as well as the closing of the opening between the breakwater and ice-breaker, or the covering that opening by a detached breakwater. Before a decision upon such modification of the existing work, a careful series of observations of tidal currents and velocities should be undertaken, and the general direction of the sea-waves observed. The board perceive the importance of the suggestions set forth in the project of the necessity of an enlarged capacity of the anchorage, and earnestly recommend the above investigations to be made by the officer in charge, that the question of the relative bearing of the pier and breakwater be now definitely determined.

Fourth.—While the board, having reference to the views above expressed, hesitates to define, at this time, the precise location of the pier, no objection is perceived to the necessary preliminary measures for the procuring of materials by the officer in charge, if it be deemed advisable.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
JOHN NEWTON,
Lieutenant Colonel of Engineers.
J. D. KURTZ,
Lieutenant Colonel of Engineers.

The board having no other business before it, adjourned at 2 p. m., to meet subject to the call of the president.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
M. R. BROWN,
First Lieutenant Corps of Engineers, Recorder.

R 5.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., July 21, 1871.

SIR: Congress, by act of July 15, 1870, (Public No. 183,) made an appropriation of $225,000 for the construction of a "good and substantial pier of stone or iron in the Delaware Bay, at or near Lewes," &c., and the work was assigned to Lieutenant Colonel J. D. Kurtz, of the Corps of Engineers, who submitted a report and plan, with estimate, on the 5th of April, 1871.

The construction by the United States of the Delaware Breakwater, and the use of the harbor made by it, rendered it necessary that there should be a landing-pier to facilitate communication from vessels lying in the harbor with the shore, and accordingly, in 1837, a wooden pile-pier was constructed by Captain (now General) R. Delafield, of the Corps of Engineers, which served its purposes for the period of eleven or twelve years, when it was rendered useless by boring-worms.

In 1859 Lieutenant Colonel (then Captain) John Newton, Corps of Engineers, in obedience to instructions from the Engineer Department, presented a project for a landing-pier, consisting of a wharf, 90 by 90 feet, supported on sixteen stone piers, to be connected with the shore by a wooden trussed-bridge 14 feet wide; to be supported upon two sets of stone piers, &c. His estimate of cost was $88,000.

In 1864 the Senate of the United States, by resolution of February 3, directed its Committee on Commerce to inquire into the expediency or necessity of constructing a pier near or opposite the town of Lewes, &c.; and, in obedience thereto, a board of engineers, consisting of Lieutenant Colonel Henry Brewerton and Captain F. E. Prime, Corps of Engineers, were instructed to examine the questions presented, and report plans of piers, with estimate cost of stone or iron structures. They accordingly prepared plans for piers with stone superstructure, and of iron, to be located at the same point chosen by Captain Newton, a short distance nearer the cape than the position occupied by the former United States wooden pier. The cost of the pier proposed by them, with stone superstructure, was estimated at $147,000, and for the iron pier on screw-piles, $114,000.

In 1869, February 4, the House of Representatives called upon the Secretary of the Treasury to furnish all the information in his possession relating to surveys made in the Delaware Breakwater Harbor, with a view to the erection of a pier; and, in obedience to the call, he forwarded to the House the maps of the survey of Lieutenant Frank Barr, of the revenue service, and also the report of Colonel Brewerton and Captain Prime, above referred to. Lieutenant Barr states the necessity for additional protection and for facilities for communicating with the shore; the main deficiencies of the harbor being, in his opinion, 1st, insufficient capacity; 2d, inadequate protection; 3d, insufficient depth of water; 4th, want of protection against ice, and, 5th, difficulty of landing and obtaining supplies; and recommends a wharf of iron piles at the most suitable place, &c.

Within a few years the harbor has been connected with the railway system of the country, and the Junction and Delaware Railroad Company have recently constructed, at a cost of $37,000, a pile-pier 1,600 feet long, for the purposes of their railroad, having 14 feet water at its head at low water. A steamer of 1,200 tons burden made constant trips to New York from this point during the busy season of last year, carrying freight and passengers. The greatest depth of water that can be reached by extending this pier is about 14 or 16 feet.

Colonel Kurtz, in his report above referred to, expresses the opinion that the pier now appropriated for is intended to afford all necessary facilities for all vessels seeking the protection of the breakwater, and while the railroad pier may be sufficient for present purposes, it will not suffice for the growing commerce of the place, fostered and encouraged as it will be by the completion of the railroad. He therefore thinks that the pier should be so located that it will be practicable by additions, if necessary, to its length to reach as deep water as the harbor affords, or as may be required by any vessels resorting to it for refitment or supplies. He indicates five positions for the proposed pier; the first, affording 16 feet water, with a length of 1,560 feet; the second, 17 to 18 feet water, with a length of 1,680 feet; the third, 19 to 20 feet water, with a length of 1,680 feet; the fourth, 21 to 22 feet, with a length of 1,720 feet; and the 5th, 22 feet water, with a length of 1,800 feet, which, by moderate prolongation, will reach the deepest water in the anchorage. He proposes to build the pier of iron with wooden superstructure, and thinks that it may be completed in two seasons' work at the estimated cost of $278,423 78.

The plan of Colonel Kurtz and the question as to the best position for the pier were referred to a board of engineer officers, consisting of Lieutenant Colonel I. C. Woodruff, Lieutenant Colonel John Newton, and Lieutenant Colonel J. D. Kurtz, Corps of Engineers, who, having fully considered all the questions bearing upon the subject, arrived at the conclusion that the plan of Colonel Kurtz fulfilled all the conditions required by the act for "a good and substantial pier," and, in regard to the question of location, they recommend that the most easterly of the positions laid down by Colonel Kurtz be adopted.

Letters from the president of the Breakwater and Junction Railroad Company and ex-Senator Saulsbury accompany the report of the board. These gentlemen favor the building of the pier at the point now occupied by the railroad company, and enter fully into the discussion of the eligibility of that point, taking the ground that it was the design of Congress in making the appropriation to conjoin to the improvements already made, and that it was passed as a substitute for a bill introduced in the Senate by Senator Saulsbury, granting aid to the Junction and Breakwater Railroad Company; that the present pier is protected from the sea by the breakwater, so that vessels may lie at it in almost any weather, &c., and that the position selected by the board is not so protected. Ex-Senator Saulsbury, it appears, had charge of the appropriation in the Senate of the United States.

Section 12 of the act making appropriations for sundry civil expenses of the Government for the year ending June 30,1871, and for other purposes, approved July 15, 1870, is as follows:

> *And be it further enacted,* That two hundred and twenty-five thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, appropriated to construct a good and substantial pier of stone or iron in the Delaware Bay, at or near Lewes, in Sussex County, in the State of Delaware, out of any money in the Treasury not otherwise appropriated, and to be expended under the direction of the Secretary of War.

Section 13 is as follows:

> *And be it further enacted,* That it may and shall be lawful for the president, directors, and company of the Junction and Breakwater Railroad, in the State of Delaware, to extend their railroad upon and over said pier, and freely to use said pier in connection with their said road, subject to such regulations and charges for maintenance and repairs as the Secretary of War may adopt.

It will be seen that the law provides that the appropriation be expended under the direction of the Secretary of War, and as the views of the board of engineers in regard to the point of location appear to be sound, they are concurred in, and respectfully recommended for approval.

The report of the board of engineers is herewith transmitted.

Very respectfully, your obedient servant,

A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

Approved by the Secretary of War.

JOHN POTTS,
Chief Clerk War Department.

JULY 28, 1871.

R 6.

Proceedings of a board of engineer officers, convened at Philadelphia, Pennsylvania, by virtue of the following order.

NEW YORK CITY, *June* 29, 1871.

The board of engineer officers constituted by Special Order No. 42, paragraph 3, headquarters Corps of Engineers, April 10, 1871, to assemble at Philadelphia, Pennsylvania, April 18, to consider and report upon the plan submitted by Lieutenant Colonel Kurtz, for a pier at Lewes, Delaware, having adjourned on 21st of April, to meet subject to the call of the president, and the proceedings of the board having been approved by the Chief of Engineers, April 22, 1871, will re-assemble at Philadelphia, Pennsylvania, on Wednesday, July 5, 1871, to conclude its proceedings.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers, President of the Board.

WEDNESDAY, *July* 5, 1871—10 a. m.

The board met pursuant to the above order. Present, all the members and the recorder.

A communication from Mr. J. S. Gibbons, president of the Junction and Breakwater Railroad Company, (appended, marked A,) inclosing a petition (appended, marked B) from residents of Lewes and vicinity, captains, pilots, and navigators, regarding the location of the pier, and a copy of a letter (appended, marked C) from the Hon. Willard Saulsbury to Mr. Gibbons, referring to the intention of Congress in the act of appropriation for the pier, were received and considered, in connection with deliberations based upon the results of surveys, ordered for the information of the board, set forth in a map, of which a tracing is herewith transmitted, marked E. Two communications from Captain Barr, United States revenue service, were read and considered, (appended, marked F and G,) and the board proceeded to examine all the charts of the vicinity of the Delaware Breakwater available, from surveys of 1828, 1842, 1863, 1870, and 1871.

Pending this consideration, the board adjourned at 5 p. m., to meet at 10 a. m. to-morrow.

THURSDAY, *July* 6, 1871—10 a. m.

The board met pursuant to adjournment. Present, all the members and the recorder.

The consultation on the subject of a proper site for the Lewes pier was resumed, and after careful study of the details, and mature deliberation, the board respectfully reports:

A reference to the chart of 1871, having upon it curves of the surveys of 1828, 1842, 1863, and 1871, shows clearly a progressive filling up of the harbor of the breakwater; an action which at present is still going on, and which may ultimately prevent vessels of deep draught from seeking the protection of the breakwater, and render this harbor of refuge available only for sea-going vessels of moderate draught, and for coasters.

Thus, between the years 1828 and 1842, the three-fathom curve has receded to the eastward about 1,100 feet; and the four-fathom curve has receded 1,000 feet. In the internal between 1842 and 1871, the three-fathom curve has receded 1,600 feet, and the four-fathom curve fully 1,200 feet.

The four-fathom curve having already receded beyond practical reach, the board have decided to locate the head of the pier within the pocket formed by the three-fathom curve, and to locate the whole pier at or near the extreme easterly position, marked by Colonel Kurtz in his report of April 5, 1871.

The precise location of the head of the pier, and its direction thence to the beach, are left to be determined by the local engineer, after more numerous soundings have been made in the vicinity of the extreme easterly position of the pier, as defined by Colonel Kurtz in the same report.

The board has been led to this assumed position of the head of the pier from the information furnished by the charts, which indicate here a permanent line of deepest water.

The board has carefully considered the questions relating to the modifications of the breakwater; its extension, the closing of the gap between the breakwater and ice-breaker, and the placing of an independent structure in front of this gap, and have not been able to come to a conclusion, but allow individual members to present their views upon these subjects to the Chief of Engineers.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
JOHN NEWTON,
Lieutenant Colonel of Engineers.
J. D. KURTZ,
Lieutenant Colonel of Engineers.

The board having no other business before it, adjourned at 4 p. m., *sine die.*

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
M. R. BROWN,
First Lieutenant Engineers, Recorder.

A.

LEWES, DELAWARE, *June* 19, 1871.

DEAR SIR: I beg leave to offer for the consideration of your board the following points and suggestions relative to the location of the iron pier in the harbor of the Delaware Breakwater:

1st. The design of Congress in making the appropriation for the pier was to conjoin the improvements already made, which are auxiliary to the breakwater, with that work; the appropriation having been passed in direct pursuance of a bill introduced by the Hon. Willard Saulsbury, in aid of the Junction and Breakwater Railroad Company. The question of location, aside from the existing improvements, viz, of the railroad and pier, already constructed, was not entertained, and hence no specific provision relative to it was included in the act of appropriation.

2d. The present pier, constituting the terminus of the Junction and Breakwater Railroad, was located by skillful engineers at that point of the coast which was proved by the experience of pilots and captains of vessels to be most under the protection of the breakwater from all the various winds, currents, and seas natural to the harbor. The depth of water at its extreme end is 16 feet mean, and at the sides sufficient for the distance of 600 feet for vessels drawing from 13 down to 10 feet. This side use of the pier was considered important, as it makes a breakwater against strong waves in either direction, and gives a total wharfage of 1,250 feet, including the transverse at its head. The pier has been in use since June, 1870, and there is no reason to doubt that the situation of it with respect to the breakwater is as advantageous as any other that might have been selected.

3d. It is presumed that the location of the former pier built by the Government was determined by the same general design of getting as much as possible under the protection of the work. The agreement of the two surveys, viz, that of the Government engineer and that of the railroad engineer, as to the point of beach most completely protected, is entitled to weight. As evidence in favor of the spot chosen, accompanying this, I hand you a paper signed by captains, navigators, and pilots, who have been practically acquainted with the harbor for many years, and whose testimony is entirely confirmatory of the judgment of the engineers aforesaid.

4th. Assuming that the location of the proposed pier was intended by Congress to be an auxiliary work to the breakwater, for the purpose of improving the harbor for the uses of commerce, and at the same time auxiliary to the only approach by land from the interior, which is by the railroad, it would appear that its location on any point of beach distant from the present pier, would be inconsistent with the design of Congress in making the appropriation.

5th. The point noted on the map of Lieutenant Colonel Kurtz, (near Baker's,) as giving the deepest water nearest shore, is liable, in the opinion of residents at Lewes, and near the spot, to the objection that it is exposed to the inward roll of the sea, between the cape and the main work, and that, consequently, vessels could not lie alongside with safety, except during a period of entire calm, which would make a pier at that point useless for commercial purposes for a great part of the year.

6th. Referring to the next foregoing specification, the steamer Pelican, drawing 12 feet water, and plying weekly between New York and Lewes, has found the sea at the pier to be so broken and moderated by the protection of the breakwater, that she was not obliged to withdraw to the immediate shelter of the work more than once during the whole of the past winter, when it was plain to the naked eye that the violence of the roll at the point near Baker's would have frequently subjected her to the necessity.

7th. In view of the changes marked on the chart of Lieutenant Colonel Kurtz, showing a wearing away of the sea-shore outside of the cape, and an equivalent accretion inside, it would seem that a gradual filling up of the beach near Barker's might be expected to take place. Although that point may show the greatest depth of water nearest shore at the present time, it does not follow that such depth will continue for an indefinite period.

8th. The gradual process of shoaling going on in the harbor is manifestly due to the division of the ebb-tide between the two gaps of the breakwater. It may be assumed that Congress will cause the upper gap to be closed at no distant period, in accordance with the advice of all the United States engineers who have successively been stationed at this post for many years past. On all plausible theories of the action of currents, it may be expected that the union of the present ebb in one volume, having but one escape, will gradually cut away the point of the cape, and widen the space to admit the roll of the sea, increasing the exposures and dangers to a pier located at a point so far down the beach as Baker's. The united works will greatly increase the capacity of the harbor opposite the present pier, and afford a more complete protection to vessels, while no such protection would be given to the location at Baker's.

9th. See letter of the Hon. Willard Saulsbury, (copy inclosed,) on behalf of our company. I claim that the question of location was not intended to be left open by Congress. The manner in which the act originated, and the modifications it underwent, do not prove any cognizance by Congress of the question of location. That body was then in deliberation on the subject of giving aid to the great railroad of the Far West, and the bill of Mr. Saulsbury was drawn and presented by him on the simple basis of affording similar aid to a railroad on the eastern coast. I might refer to the Hon. Hannibal Hamlin, of the Senate of the United States, who warmly aided the bill, for testimony confirmatory of that of Mr. Saulsbury, if further testimony is needed on this point.

10th. The present terminus of the Junction and Breakwater Railroad is laid on a causeway constructed on a bed of sand for the distance of a mile or more. Together with the pier, which projects 1,700 feet into the harbor, the cost of this terminus is set down at about $75,000. If the iron pier should be located at the point designated as Baker's, this company, in order to connect with it, would be obliged to build a new causeway over a bottom of shifting sand for a distance of nearly two miles, at a probable cost of $75,000. The uncertainty of such a foundation, and its contiguity to vast bodies of shifting sand, which cover portions of pine forests to its top branches, would be a practical objection to the construction of such a causeway, even if the point of embarkation were without fault.

11th. It is among the probabilities that the Junction and Breakwater Railroad Company will in the course of a few years substitute iron for the wooden piles of the present pier. The advantage of the new pier being built in such proximity to it as to admit of conjoining the two works at a future day, and thus to increase the value of both, is too obvious to need argument for its support.

12th. I beg to offer for your consideration the proposition that the single fact of deepest water nearest shore on a changeable sand-beach does not constitute of itself a sufficient reason for determining the site of an important and costly work intended to be permanent, and to furnish all the conveniences of a capacious sea-port to commerce. The part of the Breakwater Harbor to which vessels resort for anchorage is immediately opposite the present pier, where the space is sufficient for vessels to tack and gain an offing, or to enter and avail themselves of connection with the shore. On the contrary, as I am assured by skillful seamen, the harbor opposite Baker's is too contracted to admit of the same facilities.

Respectfully submitted. J. S. GIBBONS, *President.*

Lieutenant Colonel I. C. WOODRUFF,
Presiding Officer of Board of Engineers, &c.

B.

DEAR SIR: The undersigned, residents of Lewes and vicinity, captains of vessels, pilots, and navigators, respectfully represent that they are well acquainted with the waters, currents, and shoals of the harbor of the Delaware Breakwater; and they give it as their opinion that the point of shore at which the new pier to be built by the Government ought to be located, is in close connection with the present pier; and that there is no other part of the shore where the work would be so useful and so well protected from the effects of storms, or where there is such an extent of clear sea for the working of vessels, both in their approach and departure. This location was chosen in view of all the practical advantages in loading and discharging vessels; and if a greater depth of water be required, it can be obtained by a moderate further extension of the pier into the harbor.

Captain LABUN L. LYONS.
Captain SETH MESSICK.
Captain ERRA F. FRENCH.
Captain E. D. WEST.
Captain GEORGE CHAMBERS.
Captain JAMES DUFFEY.
Captain WM. M. FOWER.
EDWARD MAULL, *Pilot.*
Captain F. G. LUBKER.
SAMUEL WEST, *Pilot.*
DAVID S. ROULAND, *Pilot.*
Captain JNO. T. JOHNSON.
JACOB A. MARSHALL, *Pilot.*
WM. M. MARSHALL, *Pilot.*
JNO. R. PRICE, *Pilot.*
Captain PETER CHAMBERS.
HENRY LUNZ, *Pilot.*
Captain JOHN MARSHALL.
GEO. L. CHAMBERS, *Pilot.*
GEO. H. MAULL.

Lieutenant Colonel J. D. KURTZ,
United States Engineer, Philadelphia.

C.

GEORGETOWN, DELAWARE, *June* 2, 1871.

J. S. GIBBONS, Esq.:

I was astonished when I learned this morning that there was a possibility, perhaps a probability, of the pier at or near Lewes being located about a mile distant from the eastern terminus of the Junction and Breakwater Railroad.

As, perhaps, I am more familiar with the history of the appropriation of $225,000 by Congress for the building of said pier, and the motives influencing Senators and Representatives in voting for it, than any other person, I submit to you the following statement of facts:

A bill, at the session of 1869 and 1870, was under consideration in the Senate, devoting hundreds of thousands of acres of the public land to aid in the construction of a railroad or railroads in the West. I believed the moment opportune to call the attention of Senators from the Atlantic States to the fact that they were, year by year, voting away the public lands for the interest exclusively of the Western and Pacific States, without claiming for their own States a reasonable share of interest in the public lands, which were the common property of all the States composing the Federal Union; and while expressing my gratification at the rapid development of the West and of the Pacific slope, I appealed to the sense of justice of Senators from all sections to do justice to the Atlantic States.

To test that sense of justice, I offered an amendment to the bill, appropriating or donating 200,000 acres of the public lands to the Junction and Breakwater Railroad, to enable said road to construct a pier, in connection with itself, at or near Lewes. My amendment was defeated by a majority of eight votes. A number of the Senators from the Western and Pacific States waited upon me and assured me that, while they could not vote for the donations of land situated within their States, to aid an object which I seemed to feel a deep interest in, they would vote for an appropriation of money from the Treasury sufficient to accomplish the object contemplated by my amendment.

I thereupon introduced a bill, appropriating $225,000 to the Junction and Breakwater Railroad, to enable them to build a pier in connection with said road. In about a week afterward the bill was reported favorably by a unanimous vote by the Committee of Commerce, and on the next day passed the Senate unanimously. The bill was sent to the House of Representatives, and the Committee on Appropriations of that body sent for me to explain the purposes, objects, and necessity of the appropriation. I appeared before them, and made the required explanation, exhibiting to them a map, which I had caused to be prepared, locating the Junction and Breakwater Railroad, from Harrington to its terminus at Lewes, upon which was marked immediately opposite said terminus the desired location of the pier; and that there might be no mistake in reference to said location, I drew, and the committee adopted, and the House of Representatives and the Senate passed an amendment, incorporated in said bill, that the Junction and Breakwater Railroad should have the right to extend their said road in, upon, and across the pier, and be entitled to the free use and enjoyment of the same. I think I know what I was about when I introduced the bill and drew the amendments which were afterward incorporated in the bill, and I think the Senate and House knew what they were doing when they voted for the bill. I know that I meant that the pier should be erected opposite the terminus of the railroad, and I know that Senators and Representatives voting for the bill so understood it. I conversed personally with nine-tenths of the Senators, and a large majority of the members of the House, in reference to object, purposes, and contemplated connection of the pier with the road, pointing out to them the mutual advantage of the road and pier to each other. Each, of itself, would be of limited local advantage; united, their advantage and benefits would be general and unlimited.

I sincerely hope that those intrusted with the location of the pier will regard the unquestionable intention of those making provision for its erection.

Very respectfully,

WILLARD SAULSBURY.

F.

UNITED STATES REVENUE STEAMER DELAWARE,
Mobile, Alabama, November 12, 1870.

SIR: I am to-day in receipt of a letter from you, (through the Treasury Department,) regarding the sketch accompanying my report on the Delaware Breakwater Harbor; and I am exceedingly sorry to say that I did not retain a copy, as I thought those which I sent to the Department and General Torbert would be sufficient.

If, therefore, you will send me a sketch of the harbor, as you propose, I will do my best (with a defective memory) to indicate thereon such points as you desire, and will furnish you with all the information on the subject I can.

I am sorry I am too far away to call on you, for if I could see you on the spot, I could be, I am sure, of much service to you, as I was stationed there about eighteen months, and made it my study.

Very respectfully,

FRANK BARR,
Lieutenant Commanding.

Lieutenant Colonel J. D. KURTZ,
United States Engineers.

G.

REVENUE STEAMER DELAWARE,
Mobile, Alabama, January 30, 1871.

DEAR COLONEL: Returning from a cruise, find yours of 16th instant here, and hasten to comply with your request regarding views, &c.

You will please accept them with caution, as I am by no means certain that my recollection of the localities is correct.

I have endeavored to indicate on the sketch, by the arrows, the manner in which the ebb-tide runs.

In coming from the westward, the tide begins to divide; first, considerably above the ice-breaker, one portion going inside, the other, outside of that portion of the works. The portion which goes *inside*, divides again, nearly in the direction in which the ice-breaker runs, the *main* tide, or at least the *strongest* tide, runs out through the opening between the works, and, as you see by the figures inclosed in circles, has dug out the channel to a much greater depth than the figures on the sketch indicate. (I give the depth to the best of my recollection.)

The other portion of the tide divides again, one portion eddying along the beach, and deposits its silt, forming the "bar." The main portion takes a general direction toward the eastern end of the breakwater. These various divisions of the current check the force of the tide, and the consequence is, a deposit which has gradually filled up the whole western part of the harbor, and indeed all of it, for at first there were about five fathoms anywhere inside the works.

The point where the beacon-light stands has, as you see, made out, year by year, until it has rendered the eastern entrance to the harbor somewhat difficult. All this is owing to the gap in the works. That once filled, a true and strong tide would sweep through the harbor and deepen it to five or six fathoms, perhaps to nine. The point would also cease to make out, and, indeed, would probably recede to its original position, and the place would once more be what it was at first, a harbor.

The effect of the gap on the flood-tide is to create an eddy at either end of the breakwater, which I have indicated by arrows in circles. The depth of that at the eastern end I have forgotten, but at the western end it is ten feet, (as I have put on the sketch,) and is shoaling every year.

And now, colonel, as to the location of the pier. My impression at the time was, that it should be as near to Baker's house as convenience to shipping would admit. The further westward you go, the more exposed it is to the very heavy nor'westers, which almost invariably follow a southeast gale at that point. Furthermore, all stores, &c., kept for the benefit of shipping will be kept on the beach, will be brought there in vessels, and will be put on board of those needing them from the most convenient point.

Should the Government ever build a fortification at the cape, the further east the pier is the better. But the main argument for locating the work as far to the eastward as may be is, that it is more protected from all storms, and also from the ice. The main body of the ice takes the direction from abreast the old United States wharf, diagonally across the harbor, toward the eastern end of the breakwater, and the principal deposits of ice on the shore and about the railroad wharf.

What effect the railroad wharf will have on the currents, of course I cannot tell, but not much, I presume, while it will act as an ice-breaker for your work.

Should ice-breakers or piers be built, my idea was that they should be built to the westward, at the point (or a little east of it) where the tide first begins to divide, and should be built on such a line as would direct the main body of the ice outside of the ice-breaker, and only permit such ice to enter the harbor as has been broken into comparatively small masses, by striking against and passing between the piers.

As a means of finding a point of divergence of the various currents, I took a quantity of cotton wool, and selecting a perfectly calm day, went well to the westward and dropped handfulls of it at regular distances from the shore, or long way out into the bay. By noting the courses of the various floats I ascertained what I know of the currents.

There is one thing absolutely necessary to the place to make it a *good* harbor, and that is to close the gap in the works. Without this is done, it will grow shoaler year by year, as it has done for years past, until it will receive only light-draught vessels. Only room exists now for one large vessel at the eastern part, and even that is not safe.

The sketch furnished you by Conwell is evidently copied from mine, or, at least, the soundings are, except that he has not put on his all the lines of soundings which I run. I ran one from the west end of the breakwater to Baker's house; one from the east end of the point; one from the westerly end of the ice-breaker to the old United States wharf; and one from said wharf due north some distance out into the bay.

I am afraid, colonel, that this will not be of much use to you, but I scarcely know what to say. If the Department had sent me on, and I could have met you on the ground, I am sure that your inquiries would have brought answers really useful to you.

In the hope, however, that it may be of some use, and assuring you of my sincere desire to do anything I can which may be of service to you, I am, very truly, yours,

FRANK BARR.

Lieutenant Colonel J. D. KURTZ,
United States Engineers.

R 7.

IMPROVING HARBOR AT MARCUS HOOK, PENNSYLVANIA.

The work for improving harbor at Marcus Hook, which has been in progress for several years, under an appropriation of $94,000, made

March 2, 1867, has been brought to a close by the completion of the ice-piers of that harbor.

The piers just completed are four in number, hexagonal in shape, pointing up and down stream, with an extreme length of 74 feet, and breadth of 32 feet, and standing 3½ feet above high-water level. They are composed of timber crib-work, filled with rubble-stone up to low-water mark, and of a regular coursed granite facing above low water, filled likewise with rubble-stone, laid in place. The face-stones are headers and stretchers, alternately, with dove-tailed joints, the courses being secured together with cast-iron dowels; the tops are covered with thick paving flags, about 2 feet by 5 feet, and each pier has two stout stone mooring-posts for the use of vessels. The harbor is 600 feet long by about 250 feet wide. It is now much the most serviceable ice-harbor on the river, and will be of great assistance to vessels in the coming and future winters.

The work has been executed principally by contract, and affords a good illustration of the difficulties and delays which pertain so much to that kind of work. The agreements for the supply of materials, of timber, rough and cut stone, and for workmanship in wood and stone, have passed from hand to hand several times, protracting the operations through four years, making each contractor dependent upon, and dissatisfied with, the others, and subjecting the United States to largely increased expense for long-continued supervision and office expenses. While materials may often be advantageously obtained by contract, workmanship can usually be better secured, and better and cheaper results obtained, and these more promptly, by the employment of days' labor than by the contract method, especially when it is obligatory to make separate agreements for the several sorts of labor involved in the undertaking.

The expenditures during the past year have been as follows, viz:

Facing stone in place	$23,092 66
Paving stone in place	3,753 83
Rubble backing stone in place	4,092 48
Balance due on crib-work	1,996 73
Services of inspector, &c., and contingencies	1,893 16
	34,828 86

STATEMENT OF FUNDS.

Amount available July 1, 1870		$50,781 43
Expenditures for year ending June 30, 1871		34,828 86
In United States Treasury June 30, 1871	$12,450 00	
In hands of officer	3,502 57	
		15,952 57
Indebtedness July 1, 1871		4,015 03
Available for year ending June 30, 1872		11,937 54

No further appropriation is asked for this harbor.

R 8.

IMPROVEMENT OF WILMINGTON HARBOR, DELAWARE.

The improvement of this harbor is advancing satisfactorily und appropriation of $15,000, made last year for this object. The chan just cut in the mouth of the river is being deepened and widene a large rock, which has become exposed in mid-channel, a short dis above Third street bridge, will be taken up by blasting, and rem The lower channel will be deepened to 12 feet at low water, width of 145 feet, and the rock now at a level of 8 feet below low will be reduced to 12 feet. The mud, sand, and soft material channel below and above the position of the rock, will also be rem as far as the appropriation will allow.

To continue the work of improvement during the year ending Jun 1873, the sum of $15,000 is asked. This sum will suffice to depth of 12 feet at low water, from the dry-dock and Wilmington Reading Railroad wharves, down to the Delaware.

Population of Wilmington, Delaware, is 34,000; present annual crease 1,500; number of vessels registered at this port 134; tonnag same, 20,753.

The amount of capital employed in manufactures in the city of mington and its immediate vicinity is $10,855,983; value of manufac articles, $15,256,132.

Wilmington is in the collection district of Delaware, and is a por entry; light-house and fort are, respectively, Christiana Light and Delaware.

The amount of revenue collected at Wilmington during the fiscal year is $33,217 99.

Abstract of proposals and of contracts for the improvement of thi bor are transmitted herewith.

STATEMENT OF FUNDS.

Appropriation for year ending June 30, 1871	$15,0
Expended for dredging, services, advertising, &c	2,7
Balance available July 1, 1871	12,2
Appropriation asked for year ending June 30, 1873	$15,0

Abstract of proposals for improvement of Wilmington Harbor, Delaware.

No.	Name of bidder.	For dredging soft material.	For removing rock from channel.		
			For four feet.	For three feet.	For t
1	Sidney P. Shelbourne...	33 cts. per cubic yard.	$61 per cubic yd. 70 yds. = $4,270	$75 per cubic yd. 40 yds. = $3,000	[illegible]
2	F. B. Colton, secretary and treasurer American Dredging Comp'y.	35 cts. per cubic yard.	$1,270	$1,050	[illegible]
3	John Dougherty	....	....	$4,750	

Abstract of contracts for improvement of Wilmington Harbor, Delaware.

No.	Name of contractor.	Rates.	
		For dredging.	For removing rock.
1	Sidney P. Shelbourne	33c. per cubic yd.	
2	F. B. Colton, secretary and treasurer American Dredging Company		$1,270

R 9.

REPAIRING THE STONE PIERS BELONGING TO THE UNITED STATES IN THE HARBOR OF NEW CASTLE, DELAWARE.

The repair of one of these piers was commenced on the 19th of April of this year. The decayed and broken wood-work has been removed to the level of 4 feet above low water, at which level the existing timber of the pier was found to be without decay and perfectly sound. A substantial wooden platform, 6 feet wide, has been laid around the pier at that level, on which was placed a facing course of heavy dimension stone of 2 feet rise, of alternate headers and stretchers, with dovetail joints.

On the southeast corner, a second course doweled to the first has been commenced, extending 15 feet in one way and 12 in the other.

The appropriations being exhausted, operations have ceased.

The cost of the work has been as follows:

Cutting down old wood-work and clearing away filling-stone and rubbish for platform		$425 20
Repairing lower outer corner and building platform, materials	$439 78	
Workmanship	222 62	
		662 40
Cutting and setting stone		488 85
Machinery and tools, (including use of scow)		468 73
Supervision		225 00
Contingencies, advertising, &c		148 87
		2,449 05

An abstract of proposals received for doing this work is forwarded herewith. Owing to defects and inaccuracies in the bids, they were all rejected, and the work was done by days' labor, and purchase of materials in open market.

Estimate of amount necessary to complete repairs of this pier.

2,740 cubic feet stone facing, at $1 25	$3,425 00
2,700 square feet paving, at $1 00	2,700 00
3 mooring-posts	75 00
Dowels	10 00
Contingencies	790 00
	7,000 00

This harbor is one of the series of ice-harbors of the Delaware, which was established in colonial days for the benefit of commerce. It is of great value to vessels navigating the Delaware in the winter season. It has been injured and its capacity diminished by the extension of walls from the shore, as well as by the shoaling of the water consequent upon the checking of the flow of the currents by various obstructions. The general interests of commerce require that the harbor should be re-established and maintained. To effect this will require the construction of an additional ice-pier at the northern end of the harbor, one at the southern end, and the removal of the unfinished pier situated near the southern line of the works, and eventually a second pier on the southern line.

Estimate of amount necessary to construct one new hexagonal ice-pier at New Castle Harbor, length 75 feet, breadth 35 feet, to stand 4 feet 6 inches above high water.

Crib-work, labor and material	$5,200 00
Iron dowels, bolts, spikes, &c	450 00
Filling-stone, put in place	2,200 00
Facing-blocks, set in place	7,600 00
Paving-block and mooring-posts complete	1,100 00
Machinery and apparatus	700 00
Inspection and office expenses	1,000 00
Unforeseen expenses	1,750 00
Cost of one pier	20,000 00
Cost of three piers	$60,000 00
Completing repairs of existing pier	7,000 00
Total for Delaware ice-harbor at New Castle	67,000 00

STATEMENT OF FUNDS.

Appropriation by act of July 15, 1871	$2,500 00
Expended during year ending June 30, 1871	2,449 05
Amount on hand July 1, 1871	50 95
Due for advertising July 1, 1871	50 95
Appropriation asked for year ending June 30, 1873	$67,000 00

New Castle is in the collection district of Wilmington, Delaware. Fort Delaware is the nearest fort, and Christiana Light the nearest light-house. The revenue collected at Wilmington during the years 1870-'71 amounted to $33,217 99, and at Philadelphia, $7,196,736 97.

Abstract of proposals for repairing the stone piers belonging to the United States in the harbor of New Castle, Delaware.

Number.	Name of bidder.	MATERIAL—RATES.				LABOR—RATES.				
		Timber.	Iron.		Angle stone.	Repairs of crib work and putting down platform.	Cutting dovetails and joints to face-stone.	Cutting dowel holes in face-stones.	Putting face-stones in place.	Putting rubble-backing in place.
		Hemlock timber.	Bolts and spikes.	Cast-iron dowels.						
1	David Woolman		6¾ cents per lb	6¾ cents per lb						
2	Paul J. Field		6¼ cents per lb	4 cents per lb						
3	Lewis Bitting	20 cts. per lineal foot.	6 cents per lb	4½ cents per lb		15 cts. per foot	7½ cts. per foot	28 cents each	$3 50 per yard	80 cts. per yard.
4	James R. Grant		6½ cents per lb	5 cents per lb						
5	W. H. Rotan	16 cts. per lineal foot.	6 cents per lb	6 cents per lb		53 cts. per lineal foot.				
6	Leiper & Lewis				$1 50 per cubic foot.					
7	Hiram Bitting		7 cents per lb	7 cents per lb.	$1 25 per cubic foot.		Each header $9; stretcher, $12.			$2 45 per perch of 25 feet.

R 10.

CLEARING AND BUOYING THE CHANNEL OF THE SCHUYLKILL RIVER, PENNSYLVANIA.

The appropriation of $15,000 for this purpose has been applied to the requisite improvement of the river at its entrance into the Delaware, to the removal of a serious obstruction above Penrose Bridge, and to opening a cut through the shoal near Gibson's Point. The entrance to the river has been deepened 3 feet, from 15 to 18 feet at low water, and a cut 1,000 feet long and 150 feet wide has been provided for the use of vessels of large class, which now frequent this river. Just above Penrose Bridge the west shore projected strongly out into the river, making an abrupt turn necessary to vessels coming down in order that they might pass through the draw of the bridge, which was located close to this shore. When the bridge was built the trade of the Schuylkill was trifling, and the draw seems to have been placed with no anticipation of future changes. This projecting point has been materially reduced by dredging, and vessels now reach and pass the draw with comparative ease. The improvement of the river at these two points (the mouth and Penrose) allows vessels of large class convenient access to the petroleum wharves at Point Breeze, two miles above Penrose Bridge.

The cut which is in progress near Gibson's will afford better access to the extensive petroleum works there, and will allow a large class of vessels to reach the extensive marble-yards, coal-yards, &c., near Chestnut Street Bridge.

The appropriation of $10,000, available for the present year, will be applied to improving the channels at the points already named, to removing a shoal near Point Breeze, and to carry the cut near Gibson's through the channel above.

The work has been done by contract, which method is the most suitable and advantageous for the Government in work of this character.

Next year it is proposed to open the mouth of the river to a depth of 20 feet, with increased width; to remove more fully the obstacle at Penrose Bridge; to widen and deepen the cut at Gibson's, and to put the navigation of the entire river up to the Market Street Bridge in a condition more suitable to the great and increasing commerce for which it has become the medium. The commerce of the Schuylkill has been largely developed within a few years, about ten. The old maps show only a depth of 8 or 9 feet at the mouth of the river at low water. Increasing use, and particularly the employment of propeller steamers, have so improved this, that last year, when the present work was commenced, there were 15 feet of water at this point. Now there are 18 feet, and 20 feet are required. Vessels of the largest class are engaged in this commerce. Ships of 1,000 and 1,500 tons, drawing 16 and 18 feet water, now load in the river, and larger vessels will be employed if they can have the means of entering the river afforded them.

Abstract of proposals and of contracts are sent herewith.

STATEMENT OF FUNDS.

Appropriations for years 1871 and 1872		$25,000 00
Expended for dredging	$13,724 40	
Expended for services, advertising, &c	1,372 35	
		15,096 75
Available for year ending June 30, 1872		9,903 25
Appropriation asked for year ending June 30, 1873		$40,000 00

Abstract of proposals for improvement of Schuylkill River, Pennsylvania.

No.	Names of bidders.	Rates for dredging.
1	Emory R. Seward, Albany, N. Y......	24 cents per cubic yard.
2	Franklin B. Colton, treasurer American Dredging Company, Philadelphia.	30 cents per cubic yard at mouth; 40 cents per cubic yard adjacent to Penrose Ferry Bridge; 60 cents per cubic yard adjacent to Gibson's Point; 35 cents per cubic yard at Point Breeze.

Abstract of proposals for improvement of Schuylkill River, Pennsylvania.

No.	Name of bidder.	Rates of dredging.
1	F. B. Colton, secretary and treasurer American Dredging Company.	30 cents per cubic yard at the mouth; 40 cents per cubic yard adjacent to Penrose Bridge; 60 cents per cubic yard adjacent to Gibson's Point.

Abstract of contracts for improvement of Schuylkill River, Pennsylvania.

Name of contractor.	Rates.
F. B. Colton, secretary and treasurer American Dredging Company.	30 cents per cubic yard at the mouth; 40 cents per cubic yard adjacent to Penrose Bridge; 60 cents per cubic yard adjacent to Gibson's Point.

R 11.

REPORT AND ESTIMATE FOR THE COMPLETION OF THE ICE-HARBOR AT REEDY ISLAND, DELAWARE RIVER.

The ice-harbor at Marcus Hook has just been completed, and will be of great service to vessels hereafter, whenever the ice forms in the Delaware.

A small appropriation has been applied to repair, in part, the most important pier of the next harbor below, that at New Castle. My annual report for that harbor shows the importance of completing these repairs and of re-establishing that harbor, as has just been done with the one at Marcus Hook.

Further down the Delaware, at the proper interval, comes the ice-harbor on the east side of Reedy Island. Vessels coming up the river in the winter had always experienced the need of shelter at this point. Below this the water widens rapidly, and there is room to avoid the running ice. But here the difficulty becomes too great, and an anchorage was consequently availed of on the eastern side of this island.

In 1852 an appropriation was made for the formation of an ice-harbor at this position. The means appropriated were insufficient, however, for the work; it was but little more than half completed, and in a temporary way, of wood, which is now decaying.

This is the first refuge that vessels obtain coming up from sea, and from here they expect, in going down, to run for the breakwater harbor at the mouth of the bay. The lower line of piers of this harbor will, with moderate repairs, be serviceable for some years yet. The two piers which were placed on the upper line, but were not finished, are going to pieces. They require to be removed and replaced by durable structures, and the upper line should be finished by the addition of three or four more piers. The lower line also needs to be somewhat exten double line of piles, which supported the gangway from the the lower piers, has caused a large accumulation of mud at the of the harbor. These piles should be drawn, so as to permit rents to flow through that part of the harbor.

While the water has deepened in front of the works, it has materially at the bottom of the harbor, along the shore of the The removal of the obstructing piles should be beneficial here an area of sheltered space for the use of light-draught vessels.

It is proposed to use here, as at Marcus Hook and New Castle, piers, pointed up and down stream, the substructure to be timber work, and the superstructure stone blocks strongly fastened and all filled with rubble-stone. The decks to be paved blocks, and provided with stone posts for vessels to make fast

The estimated total cost of the work is as follows:

1 pier, 74 feet long by 32 feet wide, will cost	[illegible]
6 piers, (in 24 feet water)	[illegible]
1 pier, (in 18 feet water)	[illegible]
1 pier, (in 6 feet water)	[illegible]
Repairs of four existing pile-piers	[illegible]
Removing old pile-work	[illegible]
Machinery and apparatus	[illegible]
Surveys and locating work	[illegible]
Inspector, 1,200 days	[illegible]
Clerk, draughtsman, and office expenses	[illegible]
Advertising	[illegible]
Unforseen expenses	[illegible]
	[illegible]

Of this amount $100,000 can be used during the coming year.

Reedy Island is in the collection district of Delaware, and ton, Delaware, is its nearest port of entry. Fort Delaware is the fort, and Reedy Island light the nearest light-house.

The revenue collected at Wilmington during the year ending 1871, was $33,217 99, and at Philadelphia, $7,196,736 97.

Appropriation asked for year ending June 30, 1873, $100,000.

Respectfully submitted.

J. D. KURTZ,
Lieutenant Colonel of

R 12.

REMOVAL OF OBSTRUCTIONS OF SALEM RIVER, NEW JERSEY.

An examination of the mouth of this river was made in October, and the obstructions were found to consist of bars, composed of various size, extending across the channel.

An estimate was submitted, and by the act of March 3, 1871, propriation of $4,000 was made for the removal of these

A contract has been entered into for the excavation and all rock, whether loose or fast ledge, from a channel-way, two feet wide, to a depth of nine feet below ordinary low water, and it is expected that the work will be completed by the 1st of September.

Abstracts of proposals and of contracts for doing the proposed work are transmitted herewith.

STATEMENT OF FUNDS.

Appropriation by act of March 3, 1871	$4,000
Expenditures to June 30, 1871	0,000
Amount available July 1, 1871	4,000

Abstract of proposals for removal of obstructions of Salem River, New Jersey.

Name of bidder.	Rates.
Franklin B. Colton, treasurer of American Dredging Company.	$3,525 for a channel 9 feet by 200 feet; or $35 per cubic yard of stone removed.

Abstract of contracts for removal of obstructions of Salem River, New Jersey.

Name of contractor.	Rate—removing obstructions.
Franklin B. Colton, treasurer of American Dredging Company.	$3,525 for a channel 9 feet by 200 feet.

R 13.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, November 28, 1870.

GENERAL: I have the honor to present the following report of survey at mouth of Salem River, New Jersey, and project for its improvement, made in accordance with the act of July 11, 1870, section 2, (Public No. 152,) and your instructions of July 23, 1870.

There are from 7 feet of water to 17, at low water, from the city of Salem down the river and into the cove where it discharges into the Delaware. After its entrance into the cove the channel bends from westwardly to southwardly, and it is just at the bend that the obstructions to navigation occur. These consist of rocks, some of them dropped overboard from vessels carrying stone to the Delaware Breakwater, and seeking shelter in Salem River; others, rocks in their natural position, some loose, and others attached to Bed Rock. The channel has gradually deepened from natural causes and from use, so that while there has scarcely been 6 feet of water at this point heretofore, there are now 7 and 8, and the rocks are exposed and project up as much as 1½ feet.

The remedy consists in lifting and removing the projecting pieces, so as to leave the bottom smooth, with from 7 to 8 feet of water. This will do away with the existing danger to vessels, and the ultimate effect will probably be beneficial to the lower channel, (from the obstructions down to the Delaware,) where there is now a smooth bottom of sand, with 6 feet water, and a few loose rocks to be removed by lifting.

Salem City is located three miles up the river, and its commerce is carried on in the large coasting vessels that frequent the Delaware.

Its population is about 5,000. There are four glass-factories, oil-cloth factory, iron foundries and machine-shops, sash, door, and carriage factories, steam grist-mills, &c. These all receive the raw materials through the navigation of the Salem River, and ship their manufactures by that channel.

Large amounts of grain, flour, hay, fruit, vegetables, cattle, sheep, &c., are shipped in the same way. Vessels drawing 12 feet now load at the wharves, and larger vessels would enter if it were practicable.

The cost of the proposed improvement is estimated as follows:

Scows, hoisting apparatus with crew of 10 men, and a diver, sixty days, at $50 per day	$3,000 00
Powder, drill, and blasting apparatus	500 00
Contingent expenses	500 00
Total	4,000 00

It is recommended that this sum, $4,000, be a appropriated for the service of the next fiscal year.

Salem is the collection district of Bridgeton, New Jersey, which place is also the nearest port of entry. Fort Delaware is the nearest fort, and Reedy Island light is the nearest light-house.

With this report are transmitted a survey of the river, showing the channel-way and position of the obstacles to navigation, and also copy of a letter of Hon. Samuel D. Githens, the mayor of the city, presenting a statement of the business, commerce, manufactures, agriculture, produce and population of the district interested in the proposed improvement.

Very respectfully, your obedient servant,

J. D. KURTZ,
Lieutenant Colonel of Engineers.

rigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SALEM, *October* 25, 1870.

DEAR SIR: I have the honor to acknowledge the receipt of your letter dated 26th instant, asking to what extent the commerce of the country will be promoted by the work of improvement contemplated in removing obstructions from the entrance to the harbor of the city of Salem.

I would respectfully state the contemplated improvement to navigation of Salem Harbor is the removal of dangerous obstructions in the Delaware Bay, near the mouth of Salem River. These obstructions consist of bed-rock, or boulders and stone, put there in lightening vessels employed in conveying stone for the building of the Delaware Breakwater at Cape Henelopen.

Vessels drawing 12 to 14 feet can navigate Salem River. It is in the bay, at or near the entrance to Salem River, the obstructions lay.

Salem River is navigable for twenty miles, and flows, its entire course, through a rich agricultural country. Salem City is located three miles from the mouth of the river, and the large coasting vessels of the Delaware can and do load at the city wharves; but the obstructions at the mouth of the river cause these great dread, and when risks are taken by these vessels, it is at higher rates because of this danger.

The population of the City of Salem, by the late census, is about 5,000. It contains three glass factories for the manufacturing of hollow-ware, one of window-glass, oil-cloth factory, iron foundery, and machine-shops, sash and door factories, carriage-factories, fruit-canning factories, three steam grist-mills and grain store-houses, seven coal-yards, &c.; numerous dry-goods, grocery, queen's-ware, hardware, trimming, and shoe stores, all receiving the raw material, such as coal, soda, iron, tin, burlaps, paints, oils, &c., &c., through the navigation of Salem River, and sending out manufactured glass, oil-cloth, canned fruit, flour, meal, grain, &c. Besides these, from the surrounding country that has the water outlets through Salem River, are hundreds of thousands of bushels of grain, hay, fruits, potatoes, cattle, sheep, calves, swine, &c. The tonnage of Salem River is made up of steamers and sailing craft, and not less than 700 of steam and vessel tonnage pass in and out at great risk. In the grain trade, vessels carrying 10,000 bushels of grain, and drawing 12 feet of water, occasionally load at the wharves at the city of Salem. But for the danger from these obstructions much more of this heavy water-carriage would be done here. Salem County, of which Salem City is the county seat, has, by the census reports of 1850 and 1860, the leading place in the agricultural statistics of all the other counties in the State, and since 1860 the agricultural and manufacturing interest have both largely increased.

It is to secure against danger of wrecks and destruction of these great interests, coupled with the direct navigation interest, and to encourage and secure further development of her inviting resources, that this community asked of Congress to do this act of justice. I may say it is the unanimous request of 20,000 citizens of the district.

Respectfully, yours,

SAML. D. GITHENS, *Mayor.*

J. D. KURTZ,
Lieutenant Colonel Engineers.

R 14.

IMPROVEMENT OF SOUTH RIVER, NEW JERSEY.

Congress having appropriated the sum of $15,000 for the improvement of this river, the work was duly advertised to be let by contract; and, upon the opening of the bids, it was awarded to the lowest bidder. No response being received from him when he was called on to take further steps toward the execution of the papers, it became necessary to place the undertaking again. This has been done, after the loss of a good deal of time; but it is hoped that the work is in reliable hands, and that it will be carried forward steadily to its completion. The price is such that the appropriation may be expected to suffice to effect all the improvement of the navigation of this river that its business now requires.

Abstracts of proposals are sent herewith.

STATEMENT OF FUNDS.

Appropriation by act of March 3, 1871	$15,000 00
Expended to June 30, 1871	....
Amount available July 1, 1871	15,000 00

No further appropriation is now asked for this work.

Abstract of proposals for improvement of South River, New Jersey.

No.	Name of bidder.	Rates for dredging.
1	E. G. Brown	55 cents per cubic yard.
2	E. R. Seward	19½ cents per cubic yard.
3	W. H. Beard	34½ cents per cubic yard.
4	Sidney P. Shelbourne	35 cents per cubic yard; or 19 cents per cubic yard to dredge the canal and deposit material on banks 100 feet apart; or $13,200 to excavate from canal 40,000 cubic yards; and 33 cents per cubic yard for the shoals outside.
5	S. F. Shortland & Bro	38 cents per cubic yard.

R 15.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, October, 29, 1870.

GENERAL: I have the honor to submit the following report of the examination and survey of South River, New Jersey, and project for its improvement, made by me in conformity with your instructions of July 23, 1870, and as provided for in section 2 of the act approved July 11, 1870, (Public, No. 152,) "making appropriations for the repairs, preservation, and completion of certain public works on rivers and harbors, and for other purposes."

South River, from Washington, the head of steamboat navigation, to its discharge into the Raritan, passes through a low and marshy country, which makes its course tortuous, with short and sudden bends and shallow water. To remedy these difficulties a cut about 80 feet wide was made about forty years ago by the New Jersey Transportation Company. This cut substituted a straight and easy artificial navigation of about a mile for a crooked one of four miles. But the proposed depth of 6 feet at low water was not carried through the extent of the cut, the bottom of which was left irregular, affording but little aid to vessels, as they could pass only with the draught allowed by the shoalest portions of the canal.

The main improvement required for this river is to complete this artificial channel to a uniform depth, corresponding to the water of the Raritan and the requirements of the business of the region dependent upon it. This is 6 feet at low water, as stated above. It will require the removal of 21,233 cubic yards of mud to effect this.

The next points needing improvements are two shoals lying between the upper end of the canal and the port of Washington. To deepen these to 6 feet will require the removal of 14,444 cubic yards of soft material. These three excavations will amount to 35,677 cubic yards.

The canal opens into the Raritan at right-angles to that river. This opening may be expected always to produce a shoal deposit at the place of meeting. To remedy this an oblique cut may be made down stream, which will blend the currents at an acute-angle. This cut will involve the removal of 3,333 cubic yards.

ESTIMATE OF PROBABLE COST OF IMPROVEMENTS.

Deepening the cut to uniform depth of 6 feet, 21,233 cubic yards, at 35 cents	$7,431 55
Opening the channel at the shoals between Washington and head of canal, 14,444 cubic yards, at 35 cents	5,055 40
Making an oblique cut into the Raritan, 3,333 cubic yards, at 35 cents	1,166 55
	13,653 50

The sum of $13,600 will suffice for all the improvements required by this river, including some minor points above Washington, between that town and Old Bridge, which is the head of navigation.

It is recommended that this amount be appropriated for the service of the next fiscal year.

The drawing transmitted herewith exhibits the position and extent of the existing obstacles to the navigation of the river.

The accompanying statement shows the value and extent of the commerce, navigation, and produce business of the region interested in the proposed improvement. The present farm products amount to $560,506 per annum. The commerce in fire and molding-sand amounts to over 12,000 tons. A very large business is done in the manufacture of bricks, amounting in the immediate vicinity to 72,000,000 yearly. Manufacturers of rubber, flour, snuff, whisky, spices, &c., exceed a million and a quarter of dollars yearly. Large increase in all these particulars is counted upon as consequent to the improvement of the navigation now asked for, and a development of market-gardening for the supply of the New York market is anticipated almost without limit. The soil is peculiarly adapted to this culture, a sure and regular channel of transportation being the one thing required to augment the business many fold.

For the particulars of these statistics, as well as for all assistance required in my examination, and particularly for the careful survey and soundings of the cut and shoals, I am indebted to the Hon. George E. Brown, of South River, New Jersey.

South River is in the collection district of Amboy. Fort at Sandy Hook is the nearest fort, and the nearest light-house that at Prince's Bay.

Very respectfully, your obedient servant,

J. D. KURTZ,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

SOUTH RIVER, *October* 10, 1870.

MY DEAR SIR: Your very kind favor of the 27th of September was received in due time.

The obtaining of the annexed statistical report, as requested, has required no little amount of exertion and time, hence the delay in replying.

I am indebted to Mr. I. G. Snedeker, census-taker for the township of East Brunswick, for the following statistics, viz:

Farms that produce over $500, only in East Brunswick Township, are valued at $550,200. Adding value of farms that do not produce $500 per annum, will raise our township farm value to $800,000; and the value of farms in the four adjoining townships to be benefited by the appropriation is nearly four times that of our own, or $3,000,000.

Number of bushels of wheat raised in our township for past year, always small	3,226
In adjoining townships	75,000
Total	78,226
Number of bushels of corn raised in our township (East Brunswick) during past year	14,945
In adjoining townships	42,000
Total	56,945
Number of bushels of potatoes raised in East Brunswick past year	17,745
Number raised in adjoining townships	70,000
Total	87,745
Number of tons of hay cut in East Brunswick past year	1,097
In adjoining townships	6,000
Total	7,097

Amount or value of production known as market gardening raised on farms that raised over $500 worth only for past year in East Brunswick	$31,893
In adjoining townships	125,000
Total	156,893

Estimated value of all farm production for the past year, including those only that raise over $500 worth of produce during past year in East Brunswick Township	$106,566
Value of all farm production raised in East Brunswick Township on farms raising under $500 per annum	50,000
Value of all farm production in adjoining townships	404,000
Total	560,566

Number of tons sand—fire and molding—shipped during 1869, by vessels belonging to New York, Boston, and Philadelphia, &c	9,320
By vessels belonging in South River	2,700
Total	12,020

Amount of wood shipped during past year from East Brunswick Township, 4,000 cords.

Cannot obtain statistics of cord-wood from adjoining townships; average price per cord, $6.

Amount of brick made during past year in the immediate vicinity of South River, 72,000,000; value, $7 50 per thousand.

There are forty vessels, light draught, giving a sum total of 4,182 tons burden, that come and go with high water only, that are owned by South River boatmen.

There are no means of ascertaining the tonnage of vessels from Boston, New York, and Philadelphia that carried the 9,320 tons of sand, and also those that, as transient vessels in our river, freight not only sand but brick and clay, but such a trade is carried on to quite an extent. An increase of facilities or improvement of our channel will greatly increase business in sand, clay, and brick.

The population of East Brunswick in 1865 was 1,832; in 1870 it is	2,869
That of the adjoining townships	14,786
Total	17,655

For the following statistics I am indebted to Hon. Thomas Boovaeue, assessor of internal revenue. They are the returns for the past year of manufactories in these four townships.

	Value.
Snuff, 325,402 pounds	$195,241 20
Tobacco, 29,254 pounds	17,302 35
Cigars, 735,264	22,000 00
Whisky, 40,000	100,000 00
Rrubber	600,000 00
Spices	70,000 00
Flour, feed, &c., &c	250,000 00
Total	1,254,543 55

The benefits anticipated from this appropriation are as follows, viz: the permanent establishing of a steamboat route from South River village to New York. This may appear to be the grand *summum bonum* of benefit. While we admit its very great importance, we trust that other considerations mentioned below will not be left unnoticed.

By referring to the preceding statistics it will be seen that in the one item of market gardening there is no trifling interest. Our soil is particularly well adapted to "trucking," but in our present condition it is impossible to reach a timely market with perishable truck. The opening of South River will extend the route of an already established steamboat, and will place at command the privilege of the inexhaustible market of New York City.

The extent to which this one item of market gardening would be increased, the immense benefit to all this section, or the extent to which the given figures would be augmented, can scarcely be conjectured; the same influence would be realized in general farm production; all could be sold that could be raised; its result will be directly seen in jealous industry, new improvement, and great increase of wealth.

The vicinity of South River abounds in valuable sands and clays, and should the channel be made navigable for vessels drawing from six to eight feet of water, the extent to which this trade alone could be opened with the principal port cities of the Atlantic States can hardly be estimated.

The brick trade would be benefited and augmented in the same ratio, which is also an item of no small importance.

The opening of South River will be the exordium of improvement to all of southern Middlesex. The order only to survey the river has already placed an incentive in the agricultural mind that has proved quite a stimulant, and large and extensive preparations are already begun for an increase of crops during the coming year.

The vicinity of South River is admitted by all to be pleasant and attractive, and by the opening of the channel the village will be in easy communication with New York, our property will increase in value, our town will grow in numbers, and will advance and improve. Manufacturing companies have examined our place and pronounced it very desirable as a manufacturing site, but are compelled to locate elsewhere on account of the great inconvenience of our channel.

May we not hope to obtain that which will aid us in one of the strides of the progress of civilization?

Very respectfully, yours,

GE. E. BROWN.

J. D. KURTZ,
Lieutenant Colonel.

IMPROVEMENT OF THE NORTH AND SOUTH BRANCHES OF THE SHREWSBURY RIVER, NEW JERSEY.

The sum of $14,000 having been appropriated by Congress at its recent session for the improvement of this river, offers to do the work by contract were called for by public advertisements, and the undertaking was allotted to the lowest bidder. He failed, however, to respond when called upon to execute the necessary papers, and thus a serious loss of time was occasioned before inquiries could be made again in the market and the necessary arrangements perfected for commencing the work. It is now awarded to a responsible undertaker, and there is reason to expect that it will go on steadily to completion. The rate of work is such that the appropriation will suffice to make the necessary cuts to open the channels of both branches of this river at all the shoal places, and it will be seen whether dredging is a sufficient improvement to produce durable benefit to the navigation. The permanent closing of the breaches along the beach is a favorable circumstance, and the steady use of the channels by steamboats, and particularly by propellers, will have a beneficial tendency.

Abstract of proposals are sent herewith.

STATEMENT OF FUNDS.

Appropriation by act of March 3, 1871	$14,000 00
Expended to June 30, 1871, (services, &c.)	197 50
Amount available July 1, 1871	13,802 50

No further appropriation is now asked for this work.

Abstract of proposals for improvement of Shrewsbury River, New Jersey.

No.	Names of bidders.	Rates charged.
1	Edgar M. Payne	29 cents per cubic yard.
2	W. M. Tebo	26 cents per cubic yard.
3	E. G. Brown	40 cents per cubic yard.
4	Emory R. Seward	19¾ cents per cubic yard.
5	W. H. Beard	24½ cents per cubic yard.

of July 25, 1870, and to submit the accompanying pr
for the required improvements.

The entrance to Shrewsbury River is from the bott
Bay, on the west shore. The channel has usually bee
shore, following it round under the Navesink Lights,
rivers. This channel, however, has become obstruct
of sand, which lies about north of the lights, so that
entering, bear away to the southeast and northeast u
to the ocean beach, which is then followed closely till
light-house or "Highland" wharves is reached, when
liquely across the river into the old channel on the we
above. This new channel is every way objectionable,
cuitous, filled with lumps and ridges, and much of
action of the drift-sand of the beach. The remedy
through the bulk-head mentioned above and bring the
use again.

The difficulties which have affected this navigation
expected to cease for the future. The great cause of
breaching of the beach by the ocean, will probably b
after. This disturbing action was examined and repor
Lieutenant M. Harrison, of the Corps of Engineers, in
explained by him that the navigation must continu
irregularity until the beach could be made permanen
has now become the site of an important railroad, it m
that it will be carefully watched for the future, and its
ally improved. The great disturbing cause being th
provements of the navigation may now be made with
of their being permanent.

The tortuous channel now in use athwart Sandy
always be liable to injury from the roll of the sea in n
That part of it which hugs the beach shore is parti
injury from drifting sand. Both these difficulties can
turning to the old direct channel along the west shore.
a cut to be dredged through the bulk-head mentioned
is the principal and most important improvement to b

Above the entrance to this river there is but one point (Port Washington) where slight dredging is required. This will afford good water up to Red Bank, a growing and active place of business at the head of navigation.

The entrance to South Shrewsbury River, just below the Ocean House, is also obstructed by a narrow and crooked channel, which requires widening and deepening. Thence the water is good for a mile and a half up, to the last obstacle just above Jumping Point. Here the town authorities have expended about $2,000 in making a cut required to open the channel. Their means were not quite sufficient to effect the object, and their labor is partly unavailing. At this point the expenditure of $1,000 will probably be required.

To effect these improvements there will be required the following amounts:

To remove the bulk-head in the old channel, 18,000 cubic yards, at 40 cents	$7,200 00
To open and straighten the entrance to North Shrewsbury River at Rocky Point, 4,125 cubic yards, at 40 cents	1,650 00
To enlarge the channel-way at Port Washington, 2,220 cubic yards, at 40 cents	888 00
To open and straighten the entrance to South Shrewsbury, (near Ocean House,) 3,750 cubic yards, at 40 cents	1,500 00
To complete the excavation near Jumping Point, 2,500 cubic yards, at 40 cents	1,000 00
Add for contingencies	1,762 00
	14,000 00

It is recommended that this amount ($14,000) be appropriated for the next fiscal year.

The map accompanying this report exhibits the location and character of the obstacles to navigation and of the proposed improvements.

A statement is inclosed showing the number and tonnage of vessels, amount and value of commerce and property interested in the improvement. It will be observed that, in addition to the prosperous and grow- regions heretofore dependent upon these outlets for their business, the wealthy community of Long Branch will hereafter have its water communication by this line of navigation. The annual commerce of these waters amounts to about $1,200,000. The value of real estate, including Long Branch, bordering upon these channels, is $15,000,000. The business done yearly on the North Shrewsbury, principally at Red Bank, amounts to $1,800,000. The anticipated increase in values dependent upon the improvements is fourfold.

I am indebted to the Hon. Charles Haight, member of Congress, and Robert Allen, jr., esq., and other residents of the community for all the facilities needed to make the required examinations, and for the accompanying statement of the commerce and business of the rivers.

Shrewsbury River is in the collection district of Amboy. Fort at Sandy Hook is the nearest fort, and the Navesink Light the nearest lighthouse.

Very respectfully, your obedient servant,

J. D. KURTZ,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Statement of number of vessels doing business on the North Shrewsbury River, amount of tonnage, value, amount of freights annually, and value of real on said river; also, the amount of business done in merchandise in the different on above river, not including a large amount of business transacted yearly various vessels not belonging permanently in the above neighborhoods.

Name.	Rig.	Tons.	Value.
Sea Bird	Steamboat	500	$75,000
Helen	...do	400	10,000
J. B. Vovis	Schooner	50	7,000
Only Son	...do	60	9,000
Martha Price	...do	50	7,000
James Dunbar	...do	40	6,000
Enterprise	...do	75	6,000
Jordan Woolley	...do	45	5,000
Grace Hoffmire	...do	40	3,500
Emma Henricks	...do	30	2,500
Libby Worthly	...do	50	7,000
West Wind	...do	35	5,000
James Patterson	...do	50	7,500
A. J. Williams	...do	75	9,000
John Pondir	...do	50	2,000
D. Hendrickson	...do	40	5,000
Laurence Price	Sloop	40	5,000
Industry	do	40	3,000
Rio Grande	...do	30	3,000
Elizabeth	...do	30	3,000
Success	...do	30	1,500
Dolphin	...do	20	1,000
Joseph Young	...do	20	1,000
Total		1,800	184,000

Estimated value of real estate bordering on the North Shrewsbury River

Amount of business done in merchandise at Red Bank and other places bordering on North Shrewsbury River

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Statement of vessels doing business on the South Shrewsbury River, cost of tonnage, and their value; also, amount of their freights annually, and value of bordering on said river; also, the amount of business done in merchandise in the places located on above river.

Name.	Rig.	Tons.	Value.
Martha W. Corlies	Schooner	45	$8,000
Hiram Edwards	...do	33	5,000
W. T. Parker	...do	30	5,000
Laura F. Maps	...do	35	6,000
I. G. Edge	...do	25	3,500
E. Irene	...do	40	7,000
Fashion	...do	30	5,000
G. M. Patchin	...do	25	5,000
I. Van Name	do	20	4,000
Total		283	48,500

Estimated value of real estate bordering on South Shrewsbury River, including Long Branch neighborhood, adjacent thereto

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R 18.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, September

GENERAL: I have the honor to make the following report of tions for the year ending June 30, 1871, of the survey of Shoals, Delaware River, Pennsylvania.

Upon inquiry and examination of the subject, it was ascertained the survey of Horseshoe Shoals, provided for by the act of March 3, 1871, had for its object the examination and study of that part of the Delaware for the purpose of ascertaining the character, cause, and extent of the interruption of the navigation of the Delaware in that region, which recurs almost every winter during the season of severe frost, and which is occasioned by the ice covering the broad and shallow expanses on both shores, then becoming wedged and packed together in great masses, which rest on the bottom, and finally closing over the channel and packing on the flood-tide so as to cause a very serious obstruction to navigation.

The general condition of the river, the character of and changes in its shores, the peculiar form of the horseshoe reaches of the river, and its history for a considerable period back, as well as its present condition, will all afford instruction respecting this difficulty. Much information has been gathered through the courtesy and aid of persons interested in the subject; valuable charts of different dates, for fifty years back, have been obtained; records of the meteorology of the locality, extending through eighty years, are being compiled. The experience and observations of navigators familiar with the river and the views and judgment of careful observers have been furnished me on this subject. The information obtained will be compiled and digested and the result furnished as soon as practicable, with suggestions of such remedial measures as the case appears to admit of.

A survey of these shoals and their vicinity, showing depth of water, force and direction of currents, form and material of shore-lines of the river, and character of deposits on the bottom, is now being made and will be continued during the present season, when the work will be plotted and the results considered in connection with former surveys of the locality. A final report upon the subject will then be transmitted.

All of which are respectfully submitted.

J. D. KURTZ,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

R 19.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, December 29, 1870.

GENERAL: I have the honor to present the following report of an examination made by me at Chester Harbor, on the Delaware River, Pennsylvania, as provided for in section 2 of the act of 11th July, 1870, (Public No. 152,) and in conformity with your instructions of July 20, 1870, together with a project for the improvement of the harbor.

Chester Harbor is the uppermost of the series of ice-harbors which have been provided to aid in the navigation of the Delaware River during the bad season. The existing United States harbor there consists of two sets of piers, an upper and a lower, about 700 feet apart, in the direction of the stream, the inner piers being connected with the shore, and the outer ones separated from them by intervals of about 50 feet. This arrangement formed a good moderate-sized ice-harbor in front of the old town, which, at that time, was small and undeveloped. This state of things continued up to 1842, as will be seen by the accompanying Coast Survey map of the water-front of Chester, which shows that at that date no other wharf accommodations had been provided.

The growth of the city since then, however, has been rap the shore south of the United States piers is now lined w and docks for a distance of about a mile; while the ice-h been occupied by private landings and valuable business esta

Chester is most exposed to ice coming from up the river. wind blows down the long reach above from an eastwardly This sets the current to the Chester shore about the mouth Creek, and from thence it flows down the Chester reach.

The business community of Chester do not appear to favor lishment of an ice-harbor in front of their city wharves, app that the piers will interfere with the access of vessels to them.

I propose, in view of all the facts of the case, to abandon the United States harbor, which now affords but little anchorage, lish a new harbor higher up the river, abreast of the water-front. A position is shown on the drawing which affo bor about 800 feet long, with a depth of two to four fathoms The piers so established will have a tendency to break up the ice coming down the river, and turn it off from the old h the city front without inconvenience from the proposed ice-brea

The city of Chester has a population of about 9,500. The suburbs have 13,500 inhabitants. This is about double the 1860. The community is prosperous, and growing rapidly and numbers. Valuable and extensive manufacturing esta occupy the ground unreclaimed ten years ago. It is the seat ant iron-works, where, in the present season of great dep ship-building, a large iron steamship is under construction. refining establishment has imported 1,312,000 gallons of molas the season of 1870, which yielded duties amounting to $ United States Treasury.

Chester is in the collection district of Philadelphia, and th the nearest port of entry. Fort Mifflin is the nearest fort. Mifflin light is the nearest light-house.

The estimated cost of the proposed piers is as follows:

For one pier	Lumber	[illegible]
	Iron	[illegible]
	Stone	[illegible]
		[illegible]
For six piers		[illegible]
Add for contingencies, including surveys, inspection of contract work, office, &c		[illegible]
		[illegible]

Of this sum it is recommended that $25,000 be appropriated service of the fiscal year ending 30th June, 1872, if Congress decide to have the work go on.

I received all needed facilities from the mayor and a com the councils and Board of Trade, in examining the water-front business establishments of the city.

Very respectfully, your obedient servant,

J. D. KURT

Lieutenant Colonel of E

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

R 19 *a*.

UNITED STATES ENGINEER OFFICE,
Philadelphia, Pennsylvania, December 6, 1870.

GENERAL: I have the honor to present the following report of an examination and survey of the Delaware River, between the city of Trenton and Bordentown, made as provided for by the act of July 11, 1870, section 2, (Public No. 152,) and in conformity with your instructions of July 23, 1870, and to submit the accompanying project for the improvement of the river, to fit it for the required uses of trade and navigation.

The river is navigable, for 12 feet of water at low tide, up as far as the foot of Newbold's Island, (a little below Bordentown,) where in passing from 12 feet in the south channel to 12 feet in the north channel a ridge must be crossed, on which there are but 5 feet at low water. From this point 6 feet of water can be had at low water up to the Trenton Bridge, except at one position, viz, Periwig Island, three miles below the bridge, where a shoal about 800 yards in length must be passed over, having only three feet of water on it.

This shoal is the only serious obstacle to the navigation of the Delaware River in the region in question. There were formerly two channels over it—one by the west side of Periwig Island, the other on the east side.

The former channel now affords hardly 2 feet of water, and is too narrow for use. The latter, which has been in use for thirty years or more, is deeper and has more width, but is curved rather sharply in its down-stream portion.

The Delaware is subject to spring floods, which are represented to rise about 15 feet above ordinary high water, and which, with their accumulated ice, rubbish, and drift material, have produced great changes in some parts of the course of the river. This is the case at Periwig Island. From the point of the west shore opposite the head of the island for 1,200 feet up stream the river-bank is a bluff about 20 feet high, the lower part of which (from above high water to below low water) is composed of gravel and boulders imbedded in clay, &c. Above the boulder-bed the material of the bank is loam and brown earth up to the surface-soil. The floods erode and sweep away this bluff and scatter its material down the stream on the river-bottom. The soft and fine matter is washed out by the current and the gravel and boulders are left, forming the shoals about Periwig Island. In this way the west channel has been stopped by a bulk-head across its upper entrance, just at the foot of the bluff, and the force of the floods has entirely swept away the surface of the island, (which in 1844 was above high tide,) so that now it shows only toward low water.

The old western channel might be re-opened, the quantity of material to be removed being somewhat less than what is required to improve the eastern channel; but the work will cost somewhat more by the yard, (as the dredge material must be carried farther off,) while its proximity to the gravel bluff makes it probable that the first flood would fill the excavation again. For this reason it is considered safer to apply the work of improvement to the eastern channel.

The commerce of the river requires a channel-way of 200 feet wide. Much of it is conducted in tows of canal-boats, which have a breast of three or more boats, and these need room to pass each other in the channel. It is proposed, then, to excavate a cut through the shoal so as to afford a depth of 6 feet, with a width of 200 feet, at low water.

This cut will require the removal of 140,000 cubic yards of gravel, boulders, &c., estimated to cost 50 cents per cubic yard, or	$70,000 00
Below Newbold's Island a cut 200 feet wide, and 700 feet long, 1 foot deep, is needed; 5,000 cubic yards, at 40 cents per yard	2,000 00
Add for supervision, surveys, and office expenses	3,000 00
Total	75,000 00

To open the channel on the west side of Periwig Island will require the removal of 100,000 cubic yards of material, at 60 cents	$60,000 00
Work at Newbold's Island, as above	2,000 00
Contingent expenses	3,000 00
Total	65,000 00

The city of Trenton, at the head of the tide-water of the Delaware, is specially interested in this improvement. This city is situated in a very fertile district of country, and by means of its turnpikes, railroads, and canals gathers in large quantities of grain, coal, and iron from the surrounding regions. Its manufactures are varied and extensive, the yearly products being of the value of $12,000,000 or $13,000,000. Iron, including hardware, stoves, &c., amounts to $2,200,000 annually; dry-goods, $2,000,000; potteries, $690,000; stone and marble, $400,000; bricks, $340,000; boots, shoes, harness, soap, candles, &c., over $2,000,000.

The desired improvement of the river would open its channel for the transportation of these and other products of industry, and would add another and cheap means of transit for the distribution of these staples of life to their markets of consumption.

I received from the mayor of the city and the committee of the councils and Board of Trade all desired facilities for the examination and survey of the river; and also from the committee a statement of the business and industrial products of Trenton, (of which the above is an abstract,) and a copy of which accompanies this report.

A map of the river, with plats of the obstacles to its navigation and the proposed improvement, is also transmitted herewith.

Trenton is in the collection district of Burlington, the nearest port of entry being Philadelphia; the nearest fort is Fort Mifflin, and the nearest light is Fort Mifflin light.

In conclusion, the improvement of the east channel, at Periwig Island, is recommended as most advisable, at an estimated cost of $75,000, and of this amount the sum of $20,000 is asked for the service of the fiscal year ending June 30, 1872.

Very respectfully, your obedient servant,

J. D. KURTZ,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

Proceedings of a board of engineers, constituted by Special Orders No. 40, dated Headquarters Corps of Engineers, Washington, D. C., May 6, 1870.

[Special Orders No. 40.]

HEADQUARTERS CORPS OF ENGINEERS,
Washington, D. C., May 6, 1870.

To conform to the requirements of the act of Congress approved April 6, 1870, giving the consent of the United States to the erection of a bridge across the Delaware River, between Philadelphia and Camden, a Board of Engineers, to consist of Lieutenant Colonel I. C. Woodruff, Brevet Brigadier General, U. S. A., Lieutenant Colonel J. D. Kurtz, Brevet Colonel, U. S. A., and Captain W. R. King, Brevet Major, U. S. A., will assemble at Philadelphia, on Tuesday, May 10, 1870, to examine and report upon the plan and location of said bridge, and whether, when built, it will conform to the requirements of the law, "not to obstruct, impair, or injuriously modify the navigation of the river."

The Board will call upon the bridge company for all maps, plans, drawings, and papers required for their examination.

Any additional surveys or examinations that may be found necessary for the full elucidation of the subject will be made and furnished at the expense of the company.

The usual expenses of the board will be paid from the appropriation for surveys and examinations on the Atlantic coast.

By command of Brigadier General Humphreys.

THOS. LINCOLN CASEY,
Major of Engineers and Brevet Colonel, U. S. A.

MAY 10, 1870.

The board met pursuant to the foregoing order, General Woodruff and Colonel Kurtz being present.

The order of the Chief of Engineers and accompanying papers were read, and the office of the engineer of the bridge (Mr. Speakman) was visited for the purpose of procuring the necessary maps, plans, and papers. Mr. Speakman being absent, a letter was addressed to him making an appointment to meet him on the following morning.

The board then took recess until 3 o'clock p. m., of the same day, at which hour a meeting was held, all the members being present.

After further consideration of the subject, the board adjourned until 9 a. m. of the following day.

MAY 11, 1870.

The board met pursuant to adjournment, all the members being present.

Mr. Speakman appeared and was examined relative to the plan and location of the proposed bridge, and exhibited certain drawings relative thereto. He then proceeded with the board to examine the proposed site of the bridge and the shore lines of the river in that vicinity.

The board then took recess until 3 o'clock p. m. of the same day, at which time Mr. Smith, assistant to Mr. Speakman, was examined relative to certain drawings of the bridge made by him.

The Board then prepared the following memorandum of maps, drawings, and papers, required for the further investigation of the subject, and adjourned until 10 o'clock on the following day:

MEMORANDUM.

In order to enable the board to comply with the requirements of the inclosed order, the following papers and drawings will be required. These papers will form a part of the proceedings and report of the board.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers, Brevet Brig. General, U. S. A.

THOS. S. SPEAKMAN, Esq.,
Engineer in Chief, Philadelphia and Camden Bridge Company, 410 *Walnut Street, Philadelphia.*

in connection with the dimensions, combinations, and materials
5th. Each drawing to have a scale upon it, and all necessary
the usual manner.

The board met pursuant to adjournment, all the
Speakman being present.
The foregoing memorandum was presented to M
explained in detail.
Mr. Speakman being unable to state how long it
prepare the papers called for, further, that it would
months,
The Board adjourned without date.

W

Captain of Engineers, Brevet

R 21.

PHILADELPHIA, PENNSYLVANIA,

The board of engineers constituted by Special Or
Headquarters Corps of Engineers, May 6, 1870, and r
cial Orders No. 100, dated Headquarters Corps of En
19, 1870, "to examine and report upon the plan and
posed bridge across the Delaware River, between Phil
den, and whether when built it will conform to the r
law, not to obstruct, impair, or injuriously modify the
river," respectfully submits the following report:

The plan of the proposed bridge, as set forth in
specifications furnished by the engineer-in-chief of th
and which are herewith transmitted, shows the proje
ordinary suspension bridge of four spans, two being
738 feet each from center to center of towers; the hi
roadway being 111, and the lowest 72 feet in the clear
At the east end of the first span from the

rock. The piers are formed of cast-iron tubes connected by struts and tie-rods.

The location of the bridge is between the foot of Market street, Philadelphia, and Cooper street, in Camden, passing a few yards north of Smith's or Windmill Island.

The river at this point is divided into two channels, the deeper and narrower being along the Philadelphia side, and the general direction of this channel being a regular curve of about 6,000 yards radius, and nearly tangent to the axis of the draw-piers, so that a vessel entering or passing through the draw would move nearly in the direction of the current. The depth of water at the draw is 27 feet at low water, according to soundings made by the bridge company.

It should be here stated that these soundings are, on an average, about 5 feet greater than those taken by the United States Coast Survey in 1843, which difference must be attributed to a difference in reference line, or method of taking the soundings, or to the wearing away of the river bed, which is known to have taken place at certain points of the cross-section.

In regard to the *plan* or design of the bridge, the following points suggested themselves:

1. If the details of construction, such as sinking and preparing foundations, selecting materials, and proportioning the various parts of the structure, as well as the means of erecting and preserving the same, are properly attended to, there is no danger of any obstruction to the navigation of the river from the work of building the bridge, or from its falling down when completed, beyond the unavoidable risks incident to all structures of this nature.

There are in all similar works many details which cannot be fixed upon before the work is under way, and in many cases important questions must be decided and expedients adopted at the very instant the work arrives at the stage requiring these parts to be commenced, and the above opinion is therefore necessarily qualified by the proviso that due attention is paid to these matters as the work progresses. This remark applies more particularly to the foundations and substructure, which must depend in a great degree upon the nature of the strata through which they pass.

2. The approaches and abutments being entirely within the pier-lines, and in fact within the line of piers already built, can offer no obstruction to navigation either directly or by changing the regimen of the river.

3. The four piers in the water-way will undoubtedly exert more or less influence in contracting the water-way and obstructing the flow of ice, but the amount of contraction would be less than one-sixteenth of the entire width of the river, even if the piers were made solid, and the great width between piers would doubtless prevent any serious difficulty from ice-dams, especially with suitable ice-breakers attached to each pier. The effect of the piers in forming sand-bars, and otherwise changing the regimen of the river, would be much diminished by leaving the space between the rows of piles entirely open, excepting at the draw, where fenders extending to low-water mark will be required to facilitate the passage of vessels.

4. The height of the bridge as proposed in the project first submitted to the board was 130 feet at the highest point, but in the more matured plan now presented, which was prepared and fully explained by Mr. J. H. Linville, it has been found necessary to reduce this height to 111 feet, in order to diminish the excessive grade of the approaches.

This height is sufficient to pass steamboats and nearly all sailing-vessels small enough to navigate the eastern channel, or the one over which the bridge attains the above height at ordinary stages of the tide.

All the larger class of vessels are obliged to use the western channel, over the middle of which the bridge has a clear height of 91 feet at low tide. They will therefore be obliged to strike their topmasts or avail themselves of the draw. By striking their topmasts nearly all sloops and schooners will be able to pass this portion of the bridge, and many ships and other more heavily sparred vessels could pass by the same means, although the labor of sending down all the spars above the mainmast in their case would be excessive, and they would therefore avail themselves of the draw. In fact, all vessels carrying spars so high as to render their passage under the bridge doubtful, would be likely to pass through the draw. On the whole, the height as at present fixed would not be greatly improved by any addition which can practicably be made.

5. The draw is located at a point which gives as great a depth of water as is required by the class of vessels which now pass above the site of the bridge. Should any deposit form either in or near the draw, rendering it too shallow for the purposes of navigation, it should be removed at the cost of the bridge company.

6. The width of the draw (70 feet) is not sufficient to allow the new ice-boat, which is now building for the city, to pass through; and it is hardly wide enough to allow a suitable margin for the larger size of sailing-vessels with tugs alongside. It is recommended that the width of the draw be increased to allow a clear space of at least 85 feet.

The height of the draw, when raised, (160 feet,) will be ample for the largest class of vessels likely to attempt a passage. The distance between draws (*200 feet) is not sufficient to allow the draws to be operated as set forth in the specifications, unless vessels are warped through or at least moved so slowly and steadily as to be absolutely independent of wind and tide. This question is not, however, of vital interest to the navigation of the river, as the two draws are only for the purpose of securing continuous travel across the bridge, and should it be found impracticable to keep one of the draws closed while the vessel is passing the other, both draws must be open at the same time, or the space between the draws must be increased so as to render the successive passage of the draws practicable.

In conclusion, the board is of opinion that, if constructed in accordance with the foregoing views, the bridge will conform to the requirements of the law.

Respectfully submitted.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
J. D. KURTZ,
Lieutenant Colonel of Engineers.
W. R. KING,
Captain of Engineers.

The following papers and drawings are herewith transmitted:

A. Papers received from Engineer Department, (7 inclosures.)
B. †Drawings received from bridge company, (4 inclosures.)
C. Specifications received from bridge company, (1 inclosure.)
D. Certificates received from pilots and others, (2 inclosures.)

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* From outside to outside. The "200" feet is from *inside* to *inside*—that is, in the clear.—W. R. K.

† Sent by Adams' Express Company this day, October 15, 1870.

R 22.

PHILADELPHIA, PENNSYLVANIA,
December 7, 1870.

The board of engineers, constituted by Special Orders No. 40, Headquarters Corps of Engineers, May 6, 1870, having been re-convened by Special Orders No. 127, Corps of Engineers, November 17, 1870, for the consideration of certain communications received since their report of October 15, 1870, by the Secretary of War, respectfully submits the following report:

A detailed discussion of each paper separately would involve numerous repetitions and extend the report to undue length, and the report is therefore limited to a general discussion of the more important points suggested by a comparison of the views set forth in the documents under consideration.

All the communications submitted to the board may be divided into two classes, viz: those which favor and those which oppose the bridge as projected.

Of the former class are:

a. Resolutions of city council of Camden, New Jersey.
b. Letter of Joshua Raybold.
c. Letter of Lennox & Burgess.
d. Letter of Hiram Lennox.
e. Letter of J. B. Fisher.
f. Letter of Hon. Morton McMichael, with eight indorsements, forwarded by the Secretary of the Navy.

Those opposed to the bridge are:

g. Protest forwarded by Hon. Leonard Myers.
h. Resolutions of Philadelphia port wardens.
i. Letter of William Cramp & Sons.

The most prominent feature of the communications in favor of the project is the setting forth the advantages of the proposed bridge to the cities of Philadelphia and Camden, and that these advantages will be so great as to outweigh the small disadvantages which may ensue to the interests of navigation.

These statements relate to the necessity for a bridge, and were doubtless duly considered by the legislatures of Pennsylvania and New Jersey in granting charters, and by Congress in giving a conditional consent to the building of the bridge, and declaring it a post route when satisfactorily completed.

All parties agree that the bridge should be so constructed as not to obstruct navigation, but differ as to whether the plans in question are so prepared. It will be noticed that all the letters and papers advocating the bridge either express the opinion that the bridge will not obstruct navigation, or contain a proviso that it shall be so constructed. (See letter of Hon. Morton McMichael, with indorsements.)

On the other hand, the opponents of the project claim that the bridge, as designed, will be a serious obstruction, and that all they desire is to have it so modified as to remove this objection.

The only question then is, will the bridge, as designed, obstruct navigation? Or, in other words, will it conform to the requirements of the law, "not to obstruct, impair?" &c., which comes back to the primary question referred to the board.

The statements made by the advocates of the project, tending to show the small amount of the obstruction to be expected from the bridge, are essentially the same as those accepted by the board in its report of October 15, although there are certain points of difference, as will appear from the fact that the board found it necessary to recommend some modifications of the plan.

There are four essential points upon which the advocates and opponents of the proposed bridge disagree. These points were all considered in the former report of the board, but as they embrace substantially all the questions treated of in the communications under consideration, a more extended notice of them appears proper in this place, and will, perhaps, afford the most direct means of accomplishing the object of this report. These points are: 1st. The width of the draw; 2d. The double-draw system; 3d. The height of the bridge; and, 4th. The effect of the piers upon the ice.

1st. As to the width of the draw, the advocates of the bridge claim in general terms that 70 feet is wide enough for the purposes of navigation, while the protest, numerously signed, and forwarded by the Hon. Leonard Myers, states that "Few tugs will risk the passage of the draw and be responsible for the safety of the vessel they may be towing, unless the distance between the piers is at least 125 feet. The passage, as a general thing, must be made with the tide, which is about three miles per hour, and the speed of the tug must be from three to six miles faster in order to use the rudders effectively, thus making the chances for collision with the piers almost a certainty, if the piers are less than 125 feet apart. If there should be any wind at the time of passage, the chances for collision will be increased."

The exact width of draw required for this particular case, is a question which could hardly be decided even by expert pilots, without at least one trial under the circumstances supposed to exist. And the board, therefore, finds it extremely difficult to decide upon a proper width, especially since the widening of the draw diminishes the width of the clear water-way of the main channel, and thus increases the difficulty to be apprehended from floating ice.

The board is of opinion that the minimum width of 85 feet, recommended in its report, will not be too great under the circumstances, and considering the great length of the piers and splay at the ends, and that they are to present smooth planked surfaces in the opening of the draw, it would seem that, except in extreme cases of wind or tide, and, of course, unavoidable accident to machinery, a skillful pilot should be able to tow any of the class of vessels which now pass above the proposed site of the bridge, through such an opening in safety.

It is thought, however, that the results of numerous special investigations of the widths of draws on western rivers may require the Department to make considerable change in the width proposed for this draw, and it will be seen, from what follows, that if the opinions of the board were not limited to the consideration of this special project for a bridge, it might recommend that the draw be entirely dispensed with.

2d. The double-draw system is not specially approved by any of the foregoing communications advocating the bridge, although it is indorsed by implication.

In regard to this feature of the bridge, the protest already quoted says: "The arrangement by which one of the draws will be closed while the vessel is passing, will effectually prevent any attempt to pass. The captain of a vessel must know to a certainty that all the draws will be open when he approaches the bridge, as there will be no time to stop when he reaches it, and there would be no room to swing, in case the anchor is dropped."

The common practice at draw-bridges is to begin to open the draw long before the vessel reaches it; in fact, many times the distance between the draws in the proposed bridge must be allowed in order to avoid accident, even when the machinery of the draw is in complete working order. With three draws, each liable to get out of order, it would be extremely dangerous for a vessel to attempt a passage unless, as above stated, all the draws were seen to be open. By suitable arrangements for the purpose, and taking sufficient time, a vessel could be warped through as they go through canal-locks; but this would be an obstruction to the navigation of the river, and the bridge company would be obliged to open all the draws at once, or nearly so, since they would have no legal right to delay vessels in order to keep up continuous travel across the bridge.

The board, therefore, only considered this question as one relating to the convenience of the bridge company, and that it might safely be left for experience to demonstrate whether the draws could be operated as set forth in the specifications of the project.

3d. In regard to the height of the bridge, the protest forwarded by the Hon. Leonard Myers states: "The height of the bridge above the water is only 90 feet at the highest place;" and, in the last paragraph, same paper, "To avoid all difficulties, it is suggested that the bridge be made as high as the East River Bridge at New York, as the same character of vessels will pass here."

The resolutions of port wardens also "protest against the building of any bridge across the Delaware River, unless the height of such bridge will allow all vessels to pass under free of obstruction."

The height referred to as the extreme height of the bridge, 90 feet, is the height over the main or western channel. And from the foregoing it will appear, that if this height could be increased to 135 feet, the height of the East River Bridge, the objection as to height would be removed, and the draw could be entirely dispensed with. But to accomplish this and preserve the present grades and curvature of the structure, the height near the middle of the bridge, which is now 111 feet, would be increased to nearly 160 feet, and each of the approaches would require an extension of about 900 feet, as shown by the annexed diagram.

As the increase in height, if practicable, would remove all the foregoing objections, it becomes proper to inquire how such a radical change would affect the interests of the bridge company, or whether it would be reasonable to require them to make such a change.

Referring to the diagram, A, A, A, floor-line of bridge, as designed, distorted two and one-half times as high as it should be for the horizontal distances represented, B, B, B.

Floor-line of bridge raised so as to give a clear height of 135 feet at the middle of the main channel, and dispensing with the draw altogether. C C. Floor-line which might be adopted, giving a clear height of 135 feet as before, but dispensing with all the piers except the two represented by dotted lines.

This last form is, of course, obtained at the expense of symmetry, but the grades would be no steeper than those designed, and there would be required but two piers, one of greatly reduced height, in the waterway, in place of the eight now required—the two draw-piers, as now designed, consisting of three piers each, and there being two other piers in the eastern channel.

This arrangement will also leave the western channel entirely unobstructed, as the first pier would stand upon the shoal north of Smith's Island, which is entirely out of the way of navigation, and could have no appreciable effect upon the regimen of the river.

The grade of the approaches, although longer, would be no steeper than at present, and would be very much shorter than by the second method of gaining sufficient height.

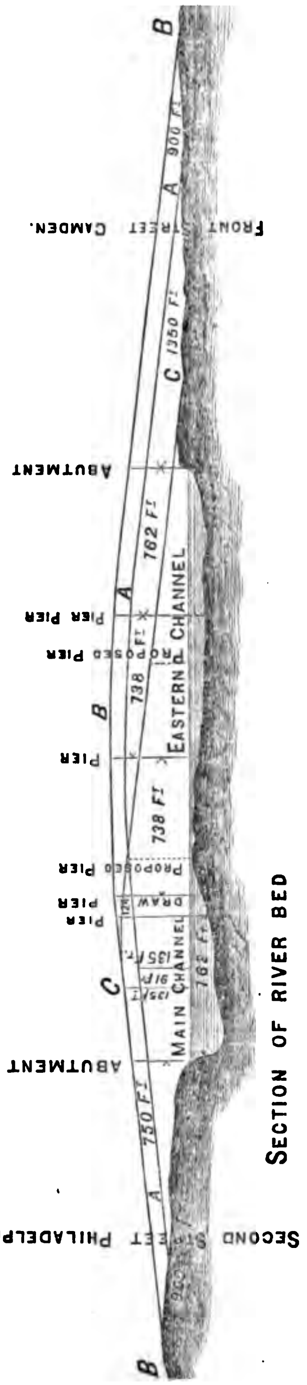


DIAGRAM.

HORIZONTAL SCALE, 1 INCH=1000 FEET.
VERTICAL DO.—1 INCH=400—DO.

The height over the eastern channel would be greatly diminished, but the navigation of this channel is pronounced, by those familiar with the locality, to be of trifling importance as compared with that of the western channel.

The length of spans required would be increased to about 1,000 feet which has been demonstrated to be entirely feasible, and it may be added that this was about the length proposed for the bridge at the first meeting of the board, the spans being shortened and increased in number in order to remove the draw from the shoal near Smith's Island to deeper water along the main channel.

4th. The question of ice is thus set forth in the protest:

> But the introduction of piers in the channel, between Smith's Island or the bar and Philadelphia, is one of the most objectionable features of the draw. Now, whether the piers may be 70 or 125 feet apart on one side of a channel, now too narrow in winter, it will certainly stop the ice earlier, below the bridge as well as above it, and close the navigation when it was before open. Before the river is closed, the floating ice generally accumulates and floats along the western side of the island where it is proposed to place the piers, making it impossible for either iceboats or tugs to tow a vessel through the draws with safety.

Allusion is also made to the effect of a pier of the Camden water-works, which is stated to have hastened the closing of the river by ice at that point, and which it is thought will increase the difficulty experienced from the draw-piers of the proposed bridge.

That these piers will tend to close the river by ice cannot be doubted; but, in the opinion of the board, such effect is too remote and uncertain to constitute a valid obstruction as contemplated by the law. It is presumed that Congress is aware that all piers in navigable rivers tend to hasten the closing of those rivers by ice, and yet numerous bridges have been authorized across such rivers, requiring many piers, and producing in some cases ice-dams of formidable dimensions.

It is probable that good ice-breakers, aided by the rise and fall of tide, will prevent the ice from adhering, to any very great extent, to the piers or damming up against them.

The rate at which the river closes up will doubtless determine to a great extent the amount of influence exerted by the piers. For example, the entire river might close up in one or two days, which would allow but little time for the piers to operate, while, on the other hand, should the river just barely freeze over without the piers, it might close up entirely with their assistance, so as to obstruct navigation for several weeks.

The effect of removing the draw-piers entirely, as already proposed, would of course place this question, beyond a doubt, on the side of safety.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
J. D. KURTZ,
Lieutenant Colonel of Engineers.
W. R. KING,
Captain of Engineers.

R 23.

OFFICE OF THE CHIEF OF ENGINEERS,
Washington, D. C., May 3, 1871.

SIR: In my letter of the 22d December last, transmitting the report of a board of engineer officers convened to consider the plans of the bridge authorized by act of Congress of April 6, 1870, to be built across the Delaware River, between Philadelphia and Camden, I stated that after careful examination of the subject, the conclusion I had reached was that a bridge built according to the plan as then proposed by the bridge company would seriously obstruct the navigation of the river, but that such modifications could be made as to obviate the most serious objections brought against it, and that the company should be notified to submit another project.

The company having done so, the same board of engineer officers was directed in March last to re-convene, to consider and report upon such modified project as might be submitted, and I now have the honor to transmit their report, with accompanying papers, from which it appears that the bridge company has presented two modified plans, differing but little from each other, in which the draw system is dispensed with, and the elevation of the bridge increased.

The greatest height of 135 feet is, however, attained at a point near Smith's Island, instead of over the middle of the main channel.

But as this elevation is attained at a point where the depth of water is 25 feet at low water, it is thought that this difference is not a serious objection to the plan, and the board is therefore clearly of opinion that neither of the plans now proposed will obstruct, impair, or injuriously modify the navigation of the river.

Very respectfully, your obedient servant,
A. A. HUMPHREYS,
Brigadier General and Chief of Engineers.

Hon. W. W. BELKNAP,
Secretary of War.

The plan which requires the bridge to be built with two whole spans and two half spans is approved, and the Chief of Engineers will notify the bridge company accordingly.

WM. W. BELKNAP,
Secretary of War.

WAR DEPARTMENT, *May* 20, 1871.

R 24.

PHILADELPHIA, PENNSYLVANIA, *April* 29, 1871.

The board of engineers constituted by Special Orders No. 40, dated Headquarters Corps of Engineers, May 6, 1870, and re-convened by Special Orders No. 33, March 21, 1871, "to consider and report upon the modified project for the bridge across the Delaware River, between Philadelphia and Camden," having completed the examination of the project, respectfully submits the following report:

A brief account of the previous action of the board will perhaps afford the most direct means of explaining the nature of the modified project now proposed. At the *first* meeting of the board, in May, 1870, it was found and reported that the project was in a very crude and undigested state. The location and details were not fixed upon, soundings not taken, drawings and specifications defective, and considerable time was necessary to enable the engineer of the bridge company to supply these deficiencies.

At the *second* meeting of the board, in October, 1870, the project was found in a more matured state, the drawings and other information called for by the board having been procured. The board reported that, with certain modifications, as the widening of the draw, and requiring of the bridge company to keep all the draws open at a time, if found necessary, the bridge would conform to the requirements of the law.

At the *third* meeting, in December, 1870, the board having been re-convened "to consider certain communications received since their report of October 15," the board found but four essential points on which the advocates and opponents of the bridge differed, viz:

1st. The width of the draw.
2d. The double-draw system.
3d. The height of the bridge, and
4th. The effect of the piers upon the ice.

It was reported that the first three of these differences could be entirely removed, and the fourth greatly diminished, by increasing the height of the bridge over the main channel to 135 feet, and dispensing with the draws altogether.

At the *fourth* or present meeting of the board, the engineer of the bridge company presented two projects based upon these suggestions, differing but slightly from each other, and the level of the roadway being in both cases nearly like that called the unsymmetrical form in the report last mentioned, the chief point of difference being that the height of 135 feet is attained at a point near Smith's Island instead of over the middle of the main channel. As this elevation of the bridge is attained at a point where the depth of water is 25 feet at low water, it is thought that this difference is not a serious objection to the plans proposed.

The board is, therefore, clearly of opinion that neither of the plans now proposed will "obstruct, impair, or injuriously modify the navigation of the river."

It will be seen from the drawings that one of these plans consists of two whole spans and two half spans, while the other has three whole spans and two half spans. The former of these has but one pier in water-way, the other pier being on the bar above Smith's Island. The other plan has three piers altogether; one of them being also located on or near the bar. The former plan will, therefore, offer the least obstruction to floating ice, though either plan will be decidedly better in this respect than the one with draw-piers, formerly reported upon.

The board assumes the "port warden's line" on the Philadelphia side, and the "commissioner's line" on the Camden side, as being established water lines which they are not called upon to discuss. The profiles of the river show that the water-way has been materially encroached upon in the establishment of these lines; but, as the bridge project exhibits the shore-works of the structure as held within those lines on both banks, it is evident that their construction will not diminish the present water-way of the river.

The drawings and specifications of the modified projects are herewith transmitted.

I. C. WOODRUFF,
Lieutenant Colonel of Engineers.
J. D. KURTZ,
Lieutenant Colonel of Engineers.
W. R. KING,
Captain of Engineers, U. S. A.

APPENDIX S 1.

UNITED STATES ENGINEER OFFICE,
Houston and Greene Streets, New York, September 8, 1871.

GENERAL: In accordance with circular of June 9, 1871, from the office of the Chief of Engineers, I have respectfully to report upon the progress and condition of the works of improvement of the Hudson River between Troy and New Baltimore, during the fiscal year ending June 30, 1871.

Channel along New Baltimore Dike.—The dredging of New Baltimore Channel, 5,700 feet long, 300 feet wide, was completed; 79,615 cubic yards of material, measured in scows, having been removed during the fiscal year, affording a depth of 11 to 14 feet at mean low water. This excavation was agreed to be paid for at 23 cents per cubic yard in position, and it cost the United States only 15⅔ cents per cubic yard measured in the scows. The total amount in position was calculated at 91,194 cubic yards; the amount removed, as measured in scows, was 133,950 cubic yards.

Coeymans Dike.—This dike, built by the State of New York, was undermined and much injured for a length of 120 feet. This was repaired by the United States, but the cost, $716 24, was borne by the State commissioners.

Dike connecting Schodac and Castleton Dikes.—Eleven hundred and eighty-three feet of this dike have been completed, of which 227 feet were constructed during the fiscal year. This dike consisting of 139 feet of full dike and 1,044 feet of half-dike; has been constructed at an average cost, including filling with stone, of $4 42 per foot. There remains to be undertaken of this shore protection 1,952 fet.

Removing Overslaugh Rock.—A contract to remove the Overslaugh Rock, containing 614 cubic yards, and situated in the channel of that name, was awarded to Emory R. Seward, of Albany, in the fall of 1870, at $13 per cubic yard. The contract was limited to June 1, but at that time the whole rock had not been removed. An abstract of bids accompanies this report.

Dredging along Overslaugh Dike and Cuyler's Bar.—For the purpose of testing the truth of a report that large quantities of clinkers, cinders, and ashes were deposited, from steamers under way, in the channels along the Overslaugh and Cuyler's Dike, I directed examination of the bottom to be made with a dredge. The result of the examination proved that a large per cent. of such materials was deposited in the said channels—more in the former than in the latter. The amount dredged in this experiment was 1,960 cubic yards, costing $403`75, from the Overslaugh Channel, and 1,080 cubic yards, costing $297, from Cuyler's Bar.

Bath Dike.—This dike, 3,823 feet long, commenced May 20, 1870, was finished in the fall of the same year. The average cost was $8 42½ per linear foot.

Patroon's Island Dike.—This dike, 3,409 feet in length, and in continuation of the old United States Dike, was undertaken and finished in the fall, during the fiscal year. It was composed of cribs, which were principally filled with dredging from the channel, and cost $3 30 per linear foot.

Old State Dam.—That portion of the dam projecting into the channel, beyond the line of Patroon's Island Dike, was removed. The amount taken away was 1,289 cubic yards, at a cost of about 25 cents per cubic yard. One thousand cubic yards of this material were deposited in the before-mentioned dike.

Base Island Dike.—This dike, 5,119 feet long, and situated toward the east bank of the river, was undertaken and finished in the fall, during the fiscal year. Its construction was the same as that described for the Patroon's Island Dike. The cost was $3 55 per linear foot.

Miscellaneous.—Stone-filling, to compensate for settlement, was added in several dikes, and some slight repairs made to the Port Schuyler Dike.

No work was undertaken from the opening of the season to the end of the fiscal year. It was considered proper to await the result of surveys before maturing a plan of improvement at several important points.

Works to be undertaken during the present season.—The works which will be undertaken and probably finished during the season are—

1st. Construction of dikes at Coeymans, for the preservation of the channel, along the wharves of that village; and for the improvement of that channel. Sufficient time has elapsed to show the result of the action of the unfinished works of improvement already executed.

The necessity here exists of keeping open two channels; the principal one along the eastern bank for general use, and a smaller one, on the west bank, for the accommodation of the village of Coeymans. The information obtained from the survey has enabled me to devise a plan which will, I think, subserve both objects, but without injury to the more important.

Dikes at Coeymans.—A dike is designed to connect the wharves at Coeymans with Barren Island; this dike, by arresting the discharge through the shallow channel west of Barren Island, will benefit both of the channels under consideration. Another dike along the middle ground, in the general prolongation of the Roah Hook Dike, is intended to define the position of the middle ground, which is liable to shift from time to time, and will operate directly upon the improvement of the principal channel.

There is a gap left between this dike and that styled Roah Hook, through which a portion of the water passes to supply the small channel in front of Coeymans, and by the gradual contraction of this gap, a sufficient supply for such purpose, and no more, will be allowed to pass through. Should it be found that two channels cannot be kept open, the gap may be closed, and all the water thrown into the main channel.

Dikes at Coeyman's.—A third dike, from the extremity of Roah Hook Dike to the wharves at Coeymans, is necessary to direct properly the flow of water, and to prevent the closing of the channel intended for the accommodation of the village of Coeymans.

The estimate for the construction of these dikes, 5,500 feet in length, is $40,600; of which $37,000 can be drawn from the appropriation on hand.

2d. Dredging off the point of the middle ground, which, at present, contracts the principal channel opposite to Coeymans.

3d. Dredging a cut about 50 feet wide through Fish-House Shoal, above Albany.

4th. Leveling up the crib-dikes above Albany with timber, and completing filling with stone.

5th. Dredging a cut along Overslaugh Dike, between Overslaugh Rock and Van Wies Point.

Condition of the river—Fish-House Shoal.—Fish-House Shoal, above Albany, has been reported somewhat troublesome during the season. The depth of water over this shoal, by the last survey, made in 1870, prior to the construction of the Base Island and Patroon's Island Dikes, was only 6.5 feet, at mean low water. A slight change in the direction of the channel, which would naturally follow the construction of the dikes aforesaid, would produce a decrease of depth in the former channel, and consequently in the navigable channel, until the new channel was perfectly formed. A very slight decrease of the already limited depth is sufficient to produce trouble.

Base Island Dike.—The length of the Base Island Dike was never absolutely fixed, and it might prove a benefit to prolong it about 1,800 feet, costing $9,000.

Increased height to dikes between Albany and Troy.—With the present low dikes, the depth over the shoals between Albany and Troy, at mean low water, will not much exceed 7 feet; but it is probable that by increasing the height of the dikes, a navigable channel of 9 feet in depth, at mean low water, may be secured. But the height of the dikes should be increased upon one side only of the channel.

Condition of the river—New surveys required.—Before, however, committing one's self definitely to the idea of increasing the height of the dikes, it would be necessary to have a new survey of the whole river between Albany and Troy; and this would be useful likewise in determining the effect of the new dikes and the changes which may have taken place from other causes since the date of the former complete survey made in 1867–'68.

Port Schuyler Dike.—The old United States Dike at Port Schuyler is in need of repairs, costing $1,000.

Shoal under railroad bridge.—From the survey recommended, it will probably appear that the shoal under the railroad bridge will need removal, in order to conform to a new set of currents, and to a more direct channel. Cost, $6,000.

New railroad bridge at Albany.—Since the date of the last report, the piers for a new railroad bridge at Albany have been brought out of water. The effect of the new bridge will be, in all probability, to cause the ice-dams to be more frequent and of longer continuance, and thus create shoals above the bridges.

Cuyler's Dike and Channel.—There have been complaints within the past two years of shoaling in the channel along Cuyler's Dike. This dike and channel were the result of the labors of the State commission. A survey will be made in the early part of the next season to ascertain the exact condition of the channels and the causes of its deterioration. It is probable, however, that another dike, generally parallel to the existing dike, will be found necessary. The utmost length required, 4,000 feet, may be constructed at a cost of $28,000.

Overslaugh Dikes and Channel.—Nothing has been done in this locality beyond repairing the old United States dike. It has, however, been designed to construct a line of diking parallel to the existing dike, for a length of about 8,000 feet, at a cost of $56,000. Although detention of vessels has occurred during the past season in the channel, the results of a recent survey have demonstrated that the channel has actually increased in depth within a couple of years, and is still improving. Further improvement will undoubtedly result from the complete removal of the Overslaugh rock. An old State dam along this dike, which injuriously deflects the currents, will be removed at a cost of $5,000.

Cedar Hill Dike.—The gap of 1,000 feet left in this dike having fulfilled its object, may now, with benefit to the main channel, be closed. The effect of this will be to close the west channel, the further existence of which would serve to retard the improvement of the main channel. Cost, $6,000.

Scammerhaun's Island—condition of the river.—There may be needed here a half-dike along the eastern shore, and the cutting away of this shore to give sufficient width for the in-flow of the flood. A survey is needed to determine the character and extent of these operations. Probable cost, $30,000.

Protection of Shad Island.—This work, only of probable necessity, would cost $4,800.

Protection of Schodac Island.—The completion of this work, for a length of 1,952 feet, would cost $7,808.

Dikes at Coeymans.—The necessity of these dikes has already been fully set forth. Their total length will be 5,500 feet, and cost $40,600.

The method pursued in the improvement of the river has been to construct works of primary necessity at each locality meeting amelioration, and afterward, by means of surveys, to ascertain the expediency of a further extension, and great care has been taken to avoid constructing works of doubtful utility, or which might afterward prove injurious. So far the general plan has been successful, and promises excellent results after completion.

The following estimate will show the amount required to complete the improvement of the river:

Dikes at Coeymans	$40,600 00
Protection of Schodack Island	7,808 00
Protection of Shad Island	4,800 00
Dredging and shore protection, Scammerhaun's Island	30,000 00
Closing gap in Cedar Hill Dike	6,000 00
Removing old State dam along Overslaugh Dike	5,000 00

Removing Overslaugh rock	$7,462 00
Parallel dikes to Overslaugh Dikes	56,000 00
Parallel dike to Cuyler's Dike	28,000 00
Removing shoal under railroad bridge	6,000 00
Extending Base Island Dike	9,000 00
Leveling up Base Island and Patroon's Island Dikes	800 00
Completing filling same with stone	7,000 00
Repairs of Port Schuyler Dike	1,000 00
Surveys, dredging, and contingencies	55,994 64
	265,464 64
Deduct amount on hand available July 1, 1871	65,464 64
Asked to be appropriated	200,000 00

As the work for the improvement of the river approaches its completion, it is possible to perceive more clearly the total probable cost, and to compare this with the original estimates—

Amount already appropriated	$650,624 23
Amount asked to be appropriated	200,000 00
	850,624 23
Estimate of November, 1866	$862,297 75
Estimate of report of 1868	984,304 47

It is shown from the preceding that the cost will be within the lowest estimate made at the begining of operations upon the river. There is asked to be appropriated for the fiscal year ending June 30, 1873, the sum of $90,000, which sum will be devoted to most important objects, viz: Completion of the dikes at Coeymans; closing gap in Cedar Hill Dike; construction of dikes parallel to the Overslaugh Dike; removing old State dam along Overslaugh Dike; extension of Base Island Dike; dredging and surveying. A general survey of the river is imperatively needed. The work is located in the 14th collection district. The nearest port of entry is Albany, New York. The amount of commerce and navigation benefited is $500,000,000.

Respectfully submitted.

JOHN NEWTON,
Lieutenant Colonel Engineers, Brevet Major General.

Brevet Major General A. A. HUMPHREYS,
Chief of Engineers, Washington, D. C.

S 2.

UNITED STATES ENGINEER OFFICE,
ARMY BUILDING, HOUSTON AND GREEN STREETS,
New York, September 29, 1871.

GENERAL: I have respectfully to report upon the progress and condition of operations for the removal of the rocks obstructing navigation in the East River, including Hell Gate, for the fiscal year ending June 30, 1871.

The condition of the shaft or pit at Hallett's Point, at the period o suspension of operations in June, 1870, was, that it was still necessary to remove 873 cubic yards, in order to reduce the bottom to the level of 25 feet below mean low water.

In the latter part of July, 1870, operations were resumed at Hallett's Point, and directed to sinking further the bottom of the shaft, and to the commencement of the tunnels leading outward from the shaft.

The tunnels radiate from a central position, and as the piers between these enlarged, intermediate tunnels are struck out, cross galleries, about 25 feet between their axes, are pierced through the piers separating the tunnels.

The result of the operations of the fiscal year has been, the reduction of the floor of the shaft to the depth of 33 feet below mean low water, and the opening of tunnels and galleries to the following lengths:

Tunnel No. 1	57 feet.	Tunnel No. 7	126 feet.
Tunnel No. 2	54 feet.	Tunnel No. 8	87 feet.
Tunnel No. 3	51 feet.	Tunnel No. 9	53 feet.
Tunnel No. 4	63½ feet.	Tunnel No. 10	50 feet.
Tunnel No. 5	68 feet.	Gallery No. 1	142 feet.
Tunnel No. 6	100 feet.	Gallery No. 2	40 feet.

The cross dimensions of the tunnel vary as their penetration increases, the height becoming less. The dimensions written below correspond, the first in order, to the commencement, and the second, to the present end of the tunnels.

Tunnel No. 1, 22 feet high by 9 feet wide; 14 feet high by 13 feet wide. Tunnel No. 2, 21½ feet high by 10¼ feet wide; 11½ feet high by 12 feet wide. Tunnel No. 3, 21½ feet high by 11½ feet wide; 14 feet high by 11½ feet wide. Tunnel No. 4, 22 feet high by 10½ feet wide; 8.7 feet high by 11½ feet wide. Tunnel No. 5, 20 feet high by 11 feet wide; 7 feet high by 12½ feet wide. Tunnel No. 6, 19 feet high by 9 feet wide; 11½ feet high by 10½ feet wide. Tunnel No. 7, 19 feet high by 11½ feet wide; 12 feet high by 12 feet wide. Tunnel No. 8, 19½ feet high by 9.7 feet wide: 13 feet high by 9 feet wide. Tunnel No. 9, 17 feet high by 12.7 feet wide; 8 feet high by 9½ feet wide. Tunnel No. 10, 12½ feet high by 10 feet wide; 8 feet high by 14 feet wide. Gallery No. 1, 12 feet high by 9 feet wide. Gallery No. 2, 10½ feet high by 10 feet wide.

The amount of rock excavated and removed from the shaft and tunnels during the fiscal year was 8,306 cubic yards.

The roof over the tunnel and galleries is about 10 feet in thickness. The rock is a gneiss, with a stratification nearly vertical; it is generally hard to the drill, and requires great care in blasting, to avoid spreading the seams, and opening copious leaks.

All of the tunnels and galleries have hitherto have been driven by hand-drilling. The machinery for drilling by steam or compressed air has been ordered, and is expected soon to be in place.

The nature of the rock, the little adhesion between the strata, the narrow margin between the workmen and the water above, have necessitated the use of shallow holes and of small charges of gunpowder or nitro-glycerine. The progress has necessarily been slow, since no advantage could be taken of deep holes and large charges, to which tunnels on land pierced through large masses of rock have been indebted for their comparatively rapid rate.

From the experience in hand-drilling, it is estimated that the progress at Hallett's Point cannot exceed one-tenth of that which could be attained on land in tunnels similar in all other respects and driven by machine-drills.

The use of steam or air drills will expedite matters, perhaps double the rate, and it is indispensable to try their effect, but the necessity of shallow holes and small charges will much detract from the progress which has been attained by their use when left unhampered by such restrictions as are set forth above.

The ruling idea in conducting the work has been to take out all the rock which a due regard for strength in the remaining parts would tolerate, and in this view the tunnels have been made high and wide.

So far the leakage has drained into the shaft, from which it has been lifted by one pump of ordinary power. It will shortly become necessary, in order to preserve the necessary thickness of ten feet of roofing, to sink the floor of the tunnels. At the present time it is deemed advisable, instead of sinking the whole level, including the shaft, to depress the floor of each tunnel, inclining outward sufficiently to obtain in each case the necessary depth. Another pump, to drain the working faces of the tunnels, will be employed. The leakage, as to quantity, has never yet troubled the work. One pump, not worked to its full capacity, has hitherto sufficed, and in this respect there seems to be no cause of apprehension. After the tunnels are driven to their full extent, and the galleries excavated, the question will arise whether to blow up the rock as it stands, or, taking away the piers, to sink the level of the excavation sufficient to receive the debris of the roof.

Fortunately it is not imperative to decide the question at present, and in the interval further study of the matter, as to relative certainty, cost, and rapidity of execution will precisely determine which of the methods would be preferable.

At an early date, with the view of applying machinery to expedite the work of drilling at Hallett's Point, public advertisements inviting proposals for drilling were inserted in the daily papers. The abstract of bids is inclosed herewith.

The bids not being deemed advantageous to the public interests, were, with the consent of the Chief of Engineers, rejected.

Subsequently arrangements were made to have 20,000 lineal feet of rock-drilling executed at 83 cents per foot, the United States supplying the power. A diamond tunnel-drill has also been purchased, this form of drill, after a trial in the tunnels, having promised good results; but, in addition, the ability to "prospect" ahead of our work, which is a specialty of the diamond drill, may prove of incalculable advantage.

STEAM-DRILLING SCOW.

This machine was first put to work in the winter of 1870–'71; two rounds of charges were exploded in Diamond Reef. The appearance of floating ice compelled a suspension of work, which was resumed in the spring upon the same reef, and continued until the solid bed-rock had been covered by the blasts, of which six additional rounds were fired on this reef.

Pending the removal of the broken rock, the drilling-scow was moved to Coenties Reef, and four rounds of holes were blasted. As the grapple-boats were not employed until the termination of the fiscal year, there is no report of rock removed from these reefs embodied in this paper.

The grapple-boats are hired by the day. Experience derived from our work has shown the necessity of large charges, which vary, according to the depth of the hole, from 30 to 55 pounds of nitro-glycerine for damaged by the collisions.

The drills are lifted by steam-power and allo
weight. The drills often unscrew, and sometime
and when an open seam is encountered, the drill
run;" *i. e.*, follow the seam and become bound.
much delay and loss of time, and unless the porti
the hole can be extracted, the loss likewise of the
poses. These difficulties led early to a considerati
placing improved drilling-machines upon the do
work the drills directly, and with vastly quicker
anticipated, as has actually happened, that a coll
scow upon the dome, would sweep off anything at
and hence such project was never carried out.

Recent investigations on the subject have, howe
that, by placing the machine on the scow, it was n
a suitable connection by flexible joints, to work th
in the tubes, and experiments to this end will be u
coming winter.

It has been found perfectly practicable to hold t
fixed, or at least imperceptibly varied, during t
strongest currents in the lower part of the East R

Work will be continued upon Coenties Reef an
ing the present season, and the grapple-boats set t
broken stone after the blast.

The steam-drilling scow has fully proved its ab
practical work.

Respectfully submitted.

JOHN
Lieutenant Colonel Engineers, B
Brevet Major General A. A. HUMPHREYS,
Chief of Engineers, Washington,

Abstract of bids for drilling by machinery at Hallett's Point, New

APPENDIX T.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, August 31, 1871.

GENERAL: I have the honor to submit the annual report upon the works of survey and improvement specially under my direction during the fiscal year ending June 30, 1871, together with an outline of operations from June 30 to present date, viz:

Improvement of Providence River, Rhode Island.
Removal of Bulk-head Rock, Providence River, Rhode Island.
Improvement of Pawtucket or Seekonk River, Rhode Island.
Survey at Narraganset Pier, Rhode Island.
Construction of breakwater at Block Island, Rhode Island.
Survey and improvement of Pawcatuck River, Rhode Island and Connecticut.
Survey of Stonington Harbor, Connecticut.
Improvement of Thames River, Connecticut.
Improvement of Connecticut River.
Improvement of Connecticut River above Hartford, and below Holyoke.
Improvement of New Haven Harbor.
Survey and improvement of the Housatonic River below Derby, Connecticut.
Survey and improvement of Bridgeport Harbor, Connecticut.
Survey of Southport Harbor, Connecticut.
Improvement of Westport Harbor, Connecticut.
Survey of Norwalk Harbor, Connecticut.
Survey of Huntington Harbor, Long Island, New York.
Survey and improvement of Port Jefferson Harbor, Long Island, New York.
Survey and improvement of Peconic River, Long Island, New York.

All of which are respectfully submitted.

G. K. WARREN,
Major of Engineers, &c.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

T 1.

IMPROVEMENT OF PROVIDENCE RIVER, RHODE ISLAND.

The work under the appropriation of $5,000, made by the act approved July 11, 1870, was in progress at the date of my last annual report, September 30, 1870, (see p. 449 of printed annual report of the Chief of Engineers for 1870,) under a contract for dredging, duly made with Mr. Thomas J. Hill, of Providence, at the rate of 25 cents per cubic yard.

Mr. Hill completed the removal of 18,200.5 cubic yards of material in October. This amount included the extraction of sixty-seven piles whose tops had been formerly broken off and left to remain, giving a depth on them of only 12 feet at mean low water in the main channel.

There was at the Crook, (which is in the Providence Channel, just above the junction with the Seekonk Channel,) on the completion of this contract, practically a channel-way up to Fox Point wharf, with minimum widths as follows:

For 130 feet width, 14 feet depth at mean low water.
For 200 feet width, 12 feet depth at mean low water.
For 350 feet width, 9 feet depth at mean low water.
For 550 feet width, 6 feet depth at mean low water.

It is believed there is very little tendency for this excavated channel at the Crook to fill up, and any further appropriation would be required only to widen the passage-way on the west side. The widening at this point tends also to straighten the channel-way, and would improve the entrance for coasters, and give anchorage without obstructing the passage-way.

I send with this report a map showing the condition of the channel-way at the Crook, as left by the operations conducted under my direction in 1870. I had an examination and sketch-map made when I commenced operations, but circumstances prevented a correct determination at the time of the plane of mean low water, and this preliminary work could not afterward be accurately connected with the subsequent survey. As far as I know, Colonel Houston did not cause any surveys to be made while the dredging operations were conducted under him, and there is no map showing the condition of the channel on the completion of the dredging done at the Crook in 1867. The determination of the plane of mean low water by direct observation was a necessity, for we were unable to find the bench marks of the United States Coast Survey, or any other survey. There is too little attention paid to establishing proper "bench marks," and I cannot, in all cases, secure proper compliance with my views of their importance, even from my own assistants. No public work should be done without leaving behind a perfect record of it, in every respect, if possible.

I append to my report the report of Mr. N. E. Russell, who superintended the work of dredging last year, and made a map of the locality after the work closed. The method he employed in determining mean low and mean high water-levels is only satisfactory when the observations cover a whole lunation, but his determination practically agrees with the United States Coast Survey's determination of the rise and fall of the tide.

The future continuation of a work like this at the Crook, in the Providence River, is a question more of *facilitating* navigation than of removing an obstruction to it; and to aid in its consideration I present the following history of what has been done at this point heretofore.

The first work done by the United States engineers in the Providence River was a survey, in March 1853, by Lieutenant Rosencrans, United States Engineers, authorized by an appropriation of $1,500, made for this purpose in August, 1852. At the same time an appropriation of $5,000 was made for improvement. The improvement was carried on under Captain George Dutton, United States Engineers, in the season of 1853, (and his reports will be found in the documents accompanying the President's message at the meeting of Congress in 1853.) In his report of April 20, 1853, he attributes the formation of the shoal at the Crook to "the great predominance of the current of the Seekonk River, crossing that of the Providence River." In his report dated October 20, 1853, he says:

> The lump or obstruction known as the Crook, and composed of stiff mud and shells, upon which there was originally, according to the survey, only 4.3 feet water at low tide, has been removed to the depth of from 9 to 10 feet (and the channel generally irregularly to 9 feet, at low water, throughout its whole extent) at the present date, (with a slight exception, which it is expected to accomplish, and some widening to the westward at the lower mouth, with the present means.)

This dredging extended over an area "150 feet wide, and a length of 280 yards," and cost, including contingent expenses, an average of 30 cents a cubic yard. Captain Dutton estimated for $7,800 to widen this new channel 100 feet further to the westward.

No further appropriation was made by Congress until a report, dated January 7, 1867, was made by Mr. F. P. Webber, assistant United States Coast Survey, under instructions from Professor Bache, Superintendent United States Coast Survey, "to proceed to Providence, Rhode Island, and examine into the circumstances which have occasioned an application to Congress, for an improvement of the Providence and Pawtucket or Seekonk Rivers." (United States Coast Survey Report for 1867, page 21.) Mr. Webber's report was accompanied by a chart made in 1867, on a scale $\frac{1}{5000}$. The report says: "The proposed improvements consist of a channel 150 feet wide, 6 feet deep, and 1,200 feet long, extending from the mouth of the harbor, opposite Fox Point wharf, in a straight line to the 18-foot line of the channel, near the junction of the Providence and Seekonk Rivers." (Mr. Webber, in the foregoing, when he speaks of a channel 6 feet deep, means an *excavation of 6 feet*, for his map shows already an 8-foot channel; therefore his plan was to make a 14-foot channel up to Fox Point wharf.) "The amount of dredging necessary for the channel would be 1,080,000 cubic feet, (40,000 cubic yards,) at 2 cents per foot, (54 cents per cubic yard,) $21,600."

Mr. Webber's map gave the location of the wreck of the Mary Stevens, (Mary Stewart, in Colonel Houston's report,) opposite Sabine Point, the removal of which he estimated would cost $500. In conclusion he says, "the whole amount of the appropriation asked for, $25,000, seems to be a proper one for the proposed improvements," and this amount was appropriated in the general river and harbor bill, which became a law early in March 1867.

Mr. Webber's chart shows a depth of nine feet at the places dredged by Captain Dutton fourteen years before, except in a space about 150 —— long, which this chart shows has but 8 feet, where the dredging by Captain Dutton gave 9 feet. There may have been some dredging at this locality done, between these dates, by the city of Providence, but I am not informed that any was done.

The charge of the improvement and expenditure under this last appropriation was given to Colonel D. C. Houston, United States Engineers, and was nearly completed at the time of his annual report, dated September 11, 1867, (see Annual Documents, 1867.) In that report he says: "I submit no estimate of funds for this improvement, as the work done this season will, I think, be all that is required in the present condition of the harbor." "No vessel drawing over seven feet can go up to the wharves at low water. Now, all vessels that reach the wharves have an easy access up the harbor."

This report of Colonel Houston, and his records in this office, show that he expended for removing the wreck Mary Stevens	$2,000 00
For dredging at the Crook, 66,013 cubic yards, at 33¾ cents per yard	22,279 53
For superintendence and engineering	720 47
Total	25,000 00

It appears from this that the removal of the wreck cost $1,500 more than the estimate; but, owing to the dredging having been done at 33¾ cents, instead of 54 cents, as estimated by Mr. Webber, 66,013 cubic yards were removed, instead of only 40,000 cubic yards, as estimated for by him. It may be noticed here that, though Mr. Webber's plan was designed to give a 14-feet channel, the annual report of Colonel Houston for 1868 only claims, after the work was done, a depth of 12 feet. As already stated, there is no map in this office showing the condition of the channel immediately before and after the work was done by Colonel Houston. Colonel Houston, in his annual report of August 8, 1868, says the Crook was, previous to the "dredging, a bend in the channel, very inconvenient to navigation, especially as vessels are compelled to anchor in the channel. By widening and deepening the channel, vessels are able to make a direct course from the lower harbor into the river, and the anchorage ground has been considerably enlarged. Vessels are now enabled to carry 12 feet, at low water, up to the Fox Point wharf. The future expenditures in the improvement of the river is simply a question of widening and deepening the channel, to adapt it to the growing wants of commerce. An annual expenditure of $10,000 could, I think, be judiciously made. This expenditure should be limited to the lower harbor, *i. e.*, below Fox Point wharf."

In July 11, 1870, the appropriation of $5,000 for the further promotion of the work was made, the result of the expenditure of which is presented in the first part of this report.

A summary statement of the moneys appropriated by the United States to enlarging and deepening the entrance to the wharves of Providence is as follows:

In 1852, for survey and improvement	$6,500 00
In 1867	25,000 00
In 1870	5,000 00
Total	36,500 00

The result has been very satisfactory. Instead of having an entrance to the city of Providence giving only 4½ feet draught at low water, we now have a draught of 14 feet at all times; and as the high water of neap-tides rise four feet, vessels can every day reach the wharves drawing at least 18 feet, and in time of spring-tides, drawing 20 feet of water.

Providence is a port of entry, and the Providence River is in the Providence district. The revenue collected there in the fiscal year ending June 30, 1871, was $203,862 43.

I concur in the previous recommendation by Colonel Houston that $10,000 a year could be expended annually to an advantage in widening the channel-way in the Providence River. At the present time the excavated material can only be dumped, at high water, about five miles below the city. It would be a valuable public improvement to build the bulk-head line south of the present wharves, and dump all the material behind it, so as to fill up the flats on the land side, but this is a thing for private enterprise to attend to.

NEWPORT, RHODE ISLAND, *February* 18, 1871.

GENERAL: I have the honor to submit the following as my final report upon the operations in Providence River, accompanied by map.

The work was completed on the 1st of November, and at that time nearly 18,000 cubic yards of material had been removed from the Crook, widening and deepening the channel considerably, and putting it in such a condition as to answer all the purposes required.

It will be seen by reference to the map that there is no actual channel-way of 14 feet from the deep water of the Seekonk Channel, below Fox Point, up *to* Fox Point; but, for all practical purposes, this channel exists, and is now used.

This is accounted for by the soft material of the bottom at this point, which consists of such a liquid mass as to oppose scarcely any resistance, at low water, to vessels ploughing through it for a depth of nearly 2 feet.

The main obstacle in this channel *was* a row of some sixty-odd piles extending across it in the direction of the line A B on the accompanying map. The tops of these were nearly on a level with the bottom just described, and on several occasions have been struck by vessels drawing fourteen feet of water while attempting to pass at low tide. They were themselves the cause of complaint, rather than the depth of water upon them, as no difficulty was experienced by vessels, in any part of the channel, but that which they occupied.

From all accounts I could obtain of these piles they were originally placed in this position some sixty years ago, when the channel was much narrower than at present, and were used as dolphins in the harbor; now, are to assist vessels in coming from place to place by means of ropes. After a time they were broken off by ice and other causes, as those at present in the harbor are, and were gradually forgotten until the operations of last September again brought them to light.

After the preliminary survey of the Crook in September, 1870, I noticed, and called your attention to the presence of, a bar across the channel along the line A B, and the first cut of the dredging-machine across it revealed its cause by removing a pile about 10 inches in diameter and 15 feet long.

Soundings were at once taken, and we discovered the presence of the row just described, which, to the number of sixty-seven, were removed and carried away in the scows. This place was the only one along the line C D where the bottom was hard, and where there was a sufficient amount of material to warrant making a cut with the dredge.

This machine, a Morris & Cummings dredge, could not cut less than 2 feet at a time in such soft material, and it was decided, that instead of making a clear cut, as usual, only every other bucket should be used, leaving it to the action of the keels and propellers of passing vessels to level it down as they readily could. In this way a good deal of money was saved, and afterwards expended in widening the 12 and 9 foot channel-ways. The boats of the New York Steamship Company, drawing 14 feet while loaded, are able to pass without the least difficulty at all times of the tide. Practically, the channel between the red lines drawn from C to D is 14 feet deep, and is so used. This 14-foot channel is about 130 feet wide; the 12-foot channel is about 200 feet wide; the 9-foot channel is 350 feet wide; the 6-foot channel is 500 feet wide. All these dimensions are minimum.

The survey, a map of which accompanies this report, was made on the 14th and 15th of November, 1870.

The mean rise and fall of the tide was determined by observations taken on the 24th, 28th, 29th, and 30th of October, 1870, and on the 4th, 5th, 9th, 10th, 11th, and 15th of November, 1870, the records of which are attached to this report.

The method of determining mean-water marks, and mean rise and fall of the water, was as follows:

The height of the low-water marks on the gauge for each day was subtracted from its corresponding high-water mark on the gauge, and the sum of the remainders so obtained, divided by the number of days used, was called the mean rise and fall of the water.

The sum of the heights of high-water mark on the gauge, divided by the mean number of days, was called the mean high-water mark on the gauge. Low water was determined in like manner; or by subtracting from mean high-water mark the mean rise and fall of the tide as before determined.

Mean water was taken as intermediate (midway) between mean high and mean low water marks. Soundings were reduced to mean low water as thus determined.

As these plans of reference were not determined until the completion of this dredging in Providence River, it was found that some difference existed between them and that used to guide the dredge. As no plans had been left for reference by previous surveys, this was a necessity which could only have been remedied by a delay of the work. I am indebted to Messrs. L. S. Chase and J. P. Vose for valuable assistance.

Very respectfully,

NATHANIEL E. RUSSELL,
In Charge Survey of Providence River.

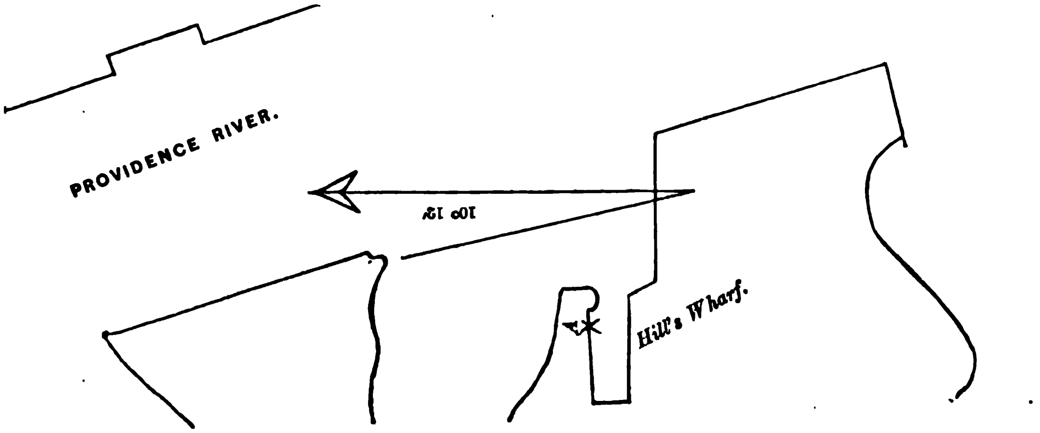
Brevet Major General G. K. WARREN,
Major Corps of Engineers, U. S. A.

Record of tide observations at Hill's wharf, Providence, Rhode Island, recorded in feet and tenths.

Date.	6 a.m.	6.30	7.	7.30	8.	8.30	9.	9.30	10.	10.30	11.	11.30	12 m.	12.30	1.	1.30	2.	2.30	3.	3.30	4.	4.30	5.	5.30	6 p.m.
1870.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
October 24	7.	7.6	8.3	7.6	7.6	7.8	7.2	6.3	5.7	4.6	3.9	3.0	2.5	1.8	1.3	1.5	2.3	2.7	3.0	3.0	3.4	4.9	5.5	5.3	5.9
October 28	3.5	3.7	4.0	4.2	5.0	5.8	5.6	6.2	6.6	7.2	7.5	7.7	7.2	6.5	5.4	4.9	4.1	3.9	2.8	2.2	1.9	1.7	1.9	2.2	2.6
October 29	3.5	4.0	4.2	4.3	4.4	......	4.5	4.8	5.1	5.8	6.5	7.1	7.2	7.4	7.1	6.8	5.7	4.8	4.0	3.3	2.5	1.7	1.7	2.0	2.3
October 30	3.7	3.0	3.7	3.8	4.0	4.2	......	4.3	4.6	4.8	5.6	6.3	7.1	7.2	7.3	7.6	7.3	6.8	6.7	5.3	4.8	4.1	3.7	3.5	3.0
November 4	6.3	6.1	5.7	5.3	4.3	4.1	3.6	3.1	2.4	2.4	2.3	2.3	2.5	2.7	3.0	3.3	4.0	4.3	4.4	4.6	5.1	5.1	5.6	6.0	6.6
November 5	6.7	6.8	6.8	6.6	6.2	5.8	5.1	4.6	4.0	3.1	2.6	2.4	2.4	2.4	2.6	3.2	3.4	3.7	4.0	4.4	4.8	5.3	5.9	6.4	6.9
November 9	6.4	6.8	7.1	7.4	7.8	8.1	8.2	8.0	7.6	7.2	6.6	6.0	5.4	5.7	4.0	3.8	3.5	3.8	4.7	4.6	4.7	4.7	4.8	5.0	5.3
November 10	5.5	5.6	5,7	5.9	5.7	5.8	6.0	6.5	6.5	6.1	5.8	5.6	4.7	4.3	3.0	2.1	1.9	1.5	1.2	2.1	2.5	2.6	3.1	3.7	4.3
November 11	4.7	4.9	5.2	5.4	5.6	5.8	6.0	6.1	6.5	6.6	6.3	6.0	5.4	4.7	4.3	3.7	2.9	2.4	2.0	2.0	2.3	2.7	3.3	3.9	4.8
November 15	5.4	5.6	5.8	6.0	6.2	6.5	6.6	6.7	7.0	7.2	7.4	7.5	7.1	6.7	5.0	5.5	4.8	4.3	3.9	3.2	3.2	3.6	3.9	4.8	......

Highest of spring tides on October 24 and November 9.

The tide-guage used at Providence was located at the point near Hill's wharf marked A on the map, and was nailed to the first pile from the corner C. The top of the sill of the wharf at this point was even with the 10-foot mark on the guage. Low-water mark on the guage was 2.24 feet; hence, the top of this sill was 7.76 feet above the plane of mean low water. The mean low water deduced from these observations agrees with the zero of the city references of Providence.



T 2.

REMOVAL OF BULK-HEAD ROCK, PROVIDENCE RIVER, RHODE ISLAND.

An appropriation of $2,500, "for the improvement of Bulk-head Rock, in Providence River, Rhode Island," was made in the civil appropriation act of July 15, 1870. This amount was based on an estimate made by Captain A. H. Holgate, United States Engineer, in a report dated June 5, 1870, printed as Senate Executive Document No. 105, second session, Forty-first Congress. He found the least depth of water on it to be 8 feet at mean low tide, and thought that it should be removed so as to give a depth of 16 feet. The amount to be removed he estimated at 25 cubic yards; and the cost, including "unforseen expenses," $100 per cubic yard.

To do this work I engaged Mr. George W. Townsend, of Boston, at $85 a day, he furnishing a sloop fitted with hoisting apparatus and hoisting engine, and his patent drill, and one foreman, one engineer, one driver, and six men, the United States furnishing the necessary powder and exploders.

Mr. George H. Mann, civil engineer, was placed to superintend the operations. He made a survey of the rock, in October, before beginning work, a map of which is sent herewith. This showed the least depth on the rock, at mean low water, to be 8.9 feet, and the amount to be removed, down to the 14-foot curve, to be 27 cubic yards. As this exceeded the amount estimated by Captain Holgate to make 16 feet depth, the improvement could not be carried deeper unless the expense should prove to be less per yard than in his estimate; and my experience with Mr. Townsend's work on Middle Rock, New Haven Harbor, did not lead me to think it would be.

Mr. Townsend was employed sixteen days, about eleven of which were in blasting upon the rock, the others being occupied in getting and placing mooring, stones, &c., after which a survey was made, (copy of the map sent herewith,) and the depth was found to have been increased so as to make at least 14 feet at mean low water. The work was then stopped, the appropriation having been exhausted.

This rock, as shown by the map of it first made, was very much in ridges, and its structure being a conglomerate, made it very brittle. It was therefore a favorable case for surface blasts, and these were the kind made by Mr. Townsend's party, with the exception of a single hole drilled into a projection above the 14-foot line, just before the work was stopped. It was necessary to raise only about 15 tons of stone, the rest being thrown off alongside.

The amount of powder and exploders used was very large. The following is a statement of them:

Size of cans.	Number of cans.	Pounds of powder.	Number of exploders.	Cost.
15-gallon	2	262½	24	$75 80
10-gallon	5	500	40	139 05
8-gallon	13	1,040	78	277 16
5-gallon	7	350	40	99 05
3-gallon	10	300	30	87 82
1-gallon	9	90	27	28 95
12-gallon	1	4	3	1 50
	47	2,546½	242	709 33

Allowing for eleven days' actual work in blasting, the removal of 27 cubic yards cost as follows:

For powder and exploders and cans	$709 33
For eleven days' work of Townsend's party, at $85	935 00
Making 27 cubic yards, at $60 90	1,644 33

Mr. Townsend's party was paid for five other days at $85	$425 00
Mr. Townsend's party was also paid for two other days at $25	50 00
Mooring-stones cost	100 00
Hire of men and vessels in making survey	38 00
Superintendence on the work, and surveying, and superintendence in office, making maps, returns, &c	242 67
	2,500 00

I have been particular in reporting the expenditures on this work, so that the experience may have its full value in making future estimates.

The Bulkhead Rock now has a depth of water, at mean low tide, of 14 feet, and at mean high water of 19 feet. At low water of spring tides there is 13½ feet, and at high water of spring tides, 19½ feet.

Accompanying this report is a United States Coast Survey chart, showing the corrected location of the rock.

The appropriation of $5,000, under which the first dredging was done, at the Crook, by Captain Dutton, in 1853, was for "removing a rock near the mouth of Seekonk River, harbor of Providence." Captain Dutton says, in his report of December 29, 1852: "Upon full investigation made at that place concerning the obstruction in question, it was ascertained that there was no rock obstructing the navigation in the waters of that harbor; nor, according to the most experienced pilots of the place, in the navigable portion of the Seekonk or Providence Rivers." Captain D. must have misapprehended the length of the Providence River, which, by the United States Coast Survey Chart, extends down to Conanicut and Nayatt Points, a distance of eight miles below the junction of the Seekonk River, while Bulkhead Rock is only two and one-half miles below this junction.

To make 17 feet on this rock at mean low water will now require the removal of about 90 cubic yards of rock. To make 18 feet will require the removal of 130 cubic yards.

This latter amount should be removed eventually, but I do not consider it a pressing necessity of the present time, and submit no estimate for the purpose. The improvements that are being made in submarine blasting will make unreliable in the future any estimate based on past experience, and the amount of rock to be removed being stated, the cost of it can better be estimated when the time comes to do the work.

The nearest port of entry is Providence. It is in the Providence collection district, and the revenue collected there for the fiscal year ending June 30, 1871, was $203,862 43.

T 3.

IMPROVEMENT OF THE PAWTUCKET RIVER, RHODE ISLAND.

At the date of my last annual report, September 30, 1870, nothing had been done on this work except the making a contract with Mr.

Emory R. Seward, of Albany, New York. By the terms of his contract he was to commence work on the 1st of October, 1870, and complete it by January 1, 1871, but, for various reasons, he failed to commence until the 10th of December, and was compelled to stop in the latter part of the same month by the ice. The time for completing his contract was extended to June 30, 1871.

He resumed work on the 1st of April, and by the 30th of June had excavated 16,257 cubic yards, leaving an unexpended balance on hand at that time of about $1,000. The dredge employed excavated with some difficulty the hard slaty material of which a portion of the bottom of that part of the river is composed. This dredging was confined to that part of the Pawtucket or Seekonk River from 500 feet below Dunnel's wharf to the town of Pawtucket, a distance of about half a mile, making there a channel of 75 feet in width and with a depth of 6 feet at mean low water.

The greatest draught for vessels going to Pawtucket before this dredging was done was less than 4½ feet at mean low water. The mean rise of the tide here is about 5 feet. The depth is now 1 foot greater above Dunnel's wharf than in some places below it.

In October and November 1870, a survey of that portion of the river between Pawtucket and Bishop's Point was made by Mr. N. E. Russell, civil engineer. A copy of his report is appended. Additional surveys were made by J. H. Dager, civil engineer, from Swan Point to Spring Run, and from Bishop's Point to Swan Point by H. A. Bentley, civil engineer; these surveys were made by them while superintending the work of dredging. A map of the river from these surveys accompanies their report. It shows the condition of the river before the work of improvement under my charge was commenced. On the 29th of April, I advertised for proposals for dredging, under the appropriation of $7,000, approved March 3, 1871, and on the 7th of June they were opened. The following is an abstract of the bids received:

Abstract of proposals for improvement of the Pawtucket River, Rhode Island, received at the Engineer Office United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and address of bidders.	Excavating, as per specifications.	Commence—	Complete.
Thomas J. Hill, Providence, R. I.	33 cents per cubic yard	July 1, 1871	July 1, 1872
Edgar M. Payn, Albany, N. Y.	33 cents per cubic yard	As soon as the dredge can be got there.	June 30, 1872
Emory R. Seward, Albany, N. Y.	38 cents per cubic yard	July 1, 1871	Jan. 1, 1872

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

The contract was awarded to Mr. T. J. Hill, of Providence, Rhode Island, at 33 cents per cubic yard. Mr. Hill was, at the time of making his proposal, doing some dredging for the city of Providence, but thought he was at liberty to leave it if he wished, but when he got ready to commence work on the river, the city authorities refused to let him off until the work was finished. The work was then offered to Mr. Edgar M. Payn, of Albany, New York, whose bid was the same as Mr. Hill's. He accepted the offer and commenced work August 12, 1871.

To make the channel below Dunnel's wharf 75 feet wide, with a depth of 6 feet at mean low water, will require the removal of about 31,000 cubic yards. The funds now available will make a channel-way of this depth and width down to Spring Run. This work is now in progress.

The improvement of this river has been quite satisfactory, increasing the range of tonnage of vessels running there about twice. It is considered advisable to continue this improvement by increasing the width and depth of the channel.

The funds available will be expended during the fiscal year. Amount asked for fiscal year ending June 30, 1873, is $10,000.

Pawtucket is situated in Providence collection district, and Providence is the port of entry.

Amount of revenue collected in the fiscal year ending June 30, 1871, was $203,862 42.

UNITED STATES ENGINEER OFFICE,
Newport, Rhode Island, February 18, 1871.

GENERAL: I have the honor to submit the following report of the survey of Pawtucket River, Rhode Island.

This survey, preparatory to the dredging operations just begun, was commenced in the latter part of October, 1870, and extends from Smith's wharf, in the town of Pawtucket, to Bishop's Point.

The shore-line was run in by myself and Mr. H. N. Babcock, mechanical engineer, and on the 3d of November, assisted by Messrs. L. S. Chase and J. P. Vose, I began to make the soundings. We found the material of the bottom to be composed of coarse gravel, rock, sand, and some soft mud, and that the channel-way, as at present existing, has an average depth of nearly five feet over the distance covered by the survey.

The principal obstructions were above Dunnel's wharf, and seem to have been caused, in part, by deposits from drains leading from the town of Pawtucket. This, however, of itself, was not the only cause of the filling which has taken place at some points. The current of the river, at all times quite perceptible, formerly touched the east bank of the river at Smith's wharf, and the channel ran on this side; but a few years ago it was turned from its natural course by wharves built on the other side, thus removing the current from the place XY, (formerly deep water,) which became filled up with sediment from a neighboring sewer.

This sewer is a common box-drain about 2 feet square, and down which great quantities of fine gravel and sand come after every rain-storm. The bottom is laid bare at this point by the fall of the tide, and its appearance shows plainly how this deposit has been made.

A small peg driven into the bed of this formation, XY, near shore, and firmly enough to prevent its being washed away, was allowed to stick up about an inch above the general surface.

This was the day before the rain-storm which occurred on the 19th of October, 1870, and the next day it had entirely disappeared.

Just below this point is another shoal place, marked Z, in the channel, and which makes a great deal of trouble to vessels coming up at medium tide.

This is the spot at present being dredged, and it would seem that any channel cut from the deep water opposite Smith's wharf to this point must be more or less affected by the deposit before mentioned.

By reference to the map it will be seen that a channel of the requisite width has been marked in the direction which will necessitate the least amount of excavation. The average depth of this at present has already been stated.

The mean rise and fall of the tide was 5.08 feet, and was determined by such observations as were not so much disturbed by winds as to make them of no value. Those used were taken on the 27th, 28th, and 29th of October, and on the 5th, 7th, 8th, 9th, 10th, and 11th of November, 1870. The observations are appended to this report. The method of finding mean water marks and mean rise and fall of water was as follows:

1st. The height of low-water mark on the gauge for each day was subtracted from its corresponding high-water mark on the gauge, and the sum of these results for all the days used, divided by the *number* of days, was called the mean rise and fall of the water.

2d. The sum of the heights of high-water mark on the gauge, divided by the number of days, was called mean high-water mark on the gauge. Low water was determined in the same way, or by subtracting from mean high-water mark the mean rise and fall of the tide, as before determined.

3d. Mean water was taken as intermediate between mean high and low water marks.

Soundings were reduced to mean low water. The mean rise and fall of the tide being 5.08 feet, the proposed excavation to a depth of 6 feet at mean low water will give a depth of over 11 feet at mean high water between the extreme points indicated on the map.

The amount of excavation to secure a channel 6 feet deep at mean low water, and 75 feet wide, from opposite Bishop's Point to Smith's wharf, in Pawtucket, has been completed, and is about 13,651 cubic yards.

I am much indebted to Messrs. Chase and Vose for valuable assistance rendered on this work.

Very respectfully,

NATHANIEL E. RUSSELL,
Civil Engineer.

Brevet Major General G. K. WARREN,
Major Corps of Engineers, U. S. A.

Record of tide observations at Smith's wharf, Pawtucket, Rhode Island, recorded in feet and tenths.

Date.	6 a. m.	6.30 a. m.	7 a. m.	7.30 a. m.	8 a. m.	8.30 a. m.	9 a. m.	9.30 a. m.	10 a. m.	10.30 a. m.	11 a. m.	11.30 a. m.	12 m.	12.30 p. m.	1 p. m.	1.30 p. m.	2 p. m.	2.30 p. m.	3 p. m.	3.30 p. m.	4 p. m.	4.30 p. m.	5 p. m.	5.30 p. m.	6 p. m.	6.30 p. m.
*a*1870:	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
Oct. 27	......	2.3	3.0	3.7	4.4	5.2	5.9	6.7	7.5	7.9	7.7	7.2	6.7	5.8	5.4	4.0	3.8	2.2	2.2	2.0	1.7	1.4	1.2	......	......	......
Oct. 28	*1.8	2.1	2.6	2.8	3.0	3.5	3.9	4.5	5.1	5.6	6.0	6.4	6.8	5.9	5.1	5.6	4.0	3.5	2.8	2.4	2.0	1.4	1.1	0.7	*0.5	......
Oct. 29	......	1.9	2.4	2.8	3.1	3.3	3.2	3.2	3.7	4.9	4.5	5.0	5.6	6.1	6.0	5.6	5.1	4.5	3.9	3.3	2.5	2.0	1.7	1.4	*1.2	*0.9
Nov. 5	......	......	......	......	......	......	......	......	......	1.7	1.5	1.2	1.03	1.15	1.5	1.7	2.1	2.5	3.0	3.2	3.4	3.9	*4.5	*5.0	*5.5	......
Nov. 7	......	5.5	5.8	6.2	6.3	6.1	5.7	5.4	5.0	4.5	3.9	3.1	2.7	2.1	1.7	1.2	0.8	1.1	1.4	1.6	1.9	2.2	2.6	3.1	......	......
Nov. 8	......	......	......	......	......	......	*6.2	*6.0	*5.6	5.3	4.7	4.2	3.7	3.0	2.6	2.2	1.8	1.7	*1.3	......	......	......	......	......	......	......
Nov. 9	......	......	......	......	......	......	7.1	6.9	6.5	6.2	5.7	5.3	4.8	4.2	3.7	3.1	2.8	2.5	2.3	3.0	3.4	3.4	......	......	......	......
Nov. 10	......	......	......	......	......	......		4.8	5.2	5.1	4.7	4.4	4.0	3.6	3.1	2.6	2.0	1.6	1.1	0.8	0.9	1.2	4.0	......	......	......
Nov. 11	......	......	......	......	......	......	......	......	......	......	5.1	4.8	4.5	4.1	3.6	3.1	2.7	2.2	1.7	1.3	1.0	0.9	*0.7	......	......	......
*b*1871.																										
Apr. 29	......		......	......	......	......	3.2	3.1	3.2	3.15	3.23	3.3	3.3	......	3.7	4.1	4.7	5.4	5.9	6.3	6.5	6.1	5.7	5.6	......	......
May 1	......	......	......	......	......	3.3	2.9	2.3	2.1	1.8	1.5	1.1	1.3	1.8	2.3	2.6	2.8	3.3	3.8	4.3	5.1	5.8	6.3	6.7	......	......
May 2	......	......	......	......	4.6	4.1	3.7	3.1	2.7	2.6	2.3	1.9	1.6	1.1	1.3	1.7	2.1	......	......	......	......	......	......	......	......	......
May 3	......	......	......	......	......	5.1	4.9	4.4	4.0	3.5	3.1	2.7	2.2	1.7	1.1	0.9	1.3	1.8	2.3	2.7	......	......	......	......	......	......

* Interpolations.

a The mean rise and fall of the tide from these observations is 5.1 feet.

b These observations give mean low water 0.4 feet above that established last autumn.

The 0 of the gauge on Smith's Wharf, in Pawtucket, was 40.19 feet below the lower side of the sill of a barn on said wharf; measurement made to southeast corner of the barn. Mean low water is 1.1 feet on the gauge and 39.09 feet below the lower side of the sill.

T 4.

BLOCK ISLAND, RHODE ISLAND.

At the date of my last annual report, (September 30, 1871,) nothing had been done on this work except the making a contract for granite with Mr. John Beattie, Newport, Rhode Island.

Mr. Beattie commenced delivering stone in October, and at the end of the fiscal year had deposited 6,931 tons in the breakwater, extending it out about 500 feet from low-water mark and up to the level of mean low water. (See sketch accompanying my monthly report for June.)

Owing to the bad weather during the winter months, and the exposed position of the work, Mr. Beattie failed to complete his contract in the time required. I recommended to the Department that the time for completing his contract be extended to the 1st of October. This extension was granted.

On the 29th of April plans for a temporary harbor were submitted to the Department. The following extract is from my letter of that date:

> The breakwater in this (its present) condition furnishes little or no protection for ordinary business, and the structure must be raised some 12 feet above low water. Generally, on account of the force of the waves, the superstructure will require to be so thoroughly built as to be practically a solid rock, and must be made of regular stone, bonded and clamped and doweled. There are no facilities for this work at the present on the spot, and some kind of temporary harbor or wharf must be made.
>
> After very much consideration of this question, I have concluded to make a small inclosed harbor for a dredge-boat, pile-driver, and crane-boat, such as we must have. These cannot at present be kept at the island. The harbor will also accommodate two ordinary coasters with safety, and enable them to land their freight with certainty where we want it. It will also enable the islanders to put on a small steamboat, which will save the work considerable expense. I propose to make this harbor inclosure a timber crib, built very much after the model of those employed by Colonel Wheeler on the lakes, and filled with the same kind of stone, which is the only kind to be found on Block Island, but is there in abundance. The wood of this crib is to be of spruce, which can be rafted ashore from the coasters lying at anchor. It is therefore the cheapest material I can use. If I have allowed sufficient strength, this temporary harbor will last for twenty years.

This plan was approved, and on the 7th June proposals for material for this work, and for granite for continuing the work substructure, were received. The following is an abstract of the proposals received at that time:

Abstract of proposals for furnishing material for breakwater at Block Island, Rhode Island, received at the Engineer's Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and address of bidders.	Spruce, per M ft., b. m.	Pine, 1-inch, seasoned, planed on one side, per M feet, b. m.	Shingles, sawed, spruce, per M.	Bolts, as per specification, per pound.	Bolts, without heads, per pound.	Nails, per keg.	Cement, per barrel.		Granite.		Commence.	Complete.	Remarks.
							Deliver 500 bbls. at a time.	Deliver less than 500 bbls.	For the 6,000 tons, per ton.	For the 1,000 tons, per ton.			
C. C. Campbell, 104 and 106 John street, New York.	$27 50	$35 00	$4 00	$0 05	......	†$0 05	‡$2 40	......	$2 84	$2 84	July 1, 1871	Jan'y 1, 1872	Bid informal; not in duplicate, and not accompanied by guaranty or copies of specifications.
Finch, Engs & Co., Newport, R. I.	29 00	40 00	3 25	*4⅞	......	5 25	2 15	$2 15	......	......	July 6, 1871	Sept. 6, 1871	
Francis H. Smith, 121 and 123 Front street, New York.	31 39	29 00	5 20	......	......	......	‡2 69	......	3 39	3 29	Commence to deliver granite July, 1871, and as fast as possible.	......	All material, except granite, to be delivered by July 15, 1871.
R. S. Place & Co., 499 Water street, and 253 South street, New York.	......	......	......	*4¾	$0 04¼	......	......	......	......	......	Deliver when required.		
J. W. Gaskill, sup't Phillipsburgh Manufacturing Company, Phillipsburgh, Warren County, N. J.	......	......	......	......	4½	......	......	......	......	......	June 12, 1871	July 12, 1871	New York office of this company at 93 Liberty street.
Daniel Runkle, pres't Phillipsburgh Manufacturing Company, Phillipsburgh, Warren County, N. J.	......	......	......	5⅛	......	......	......	......	......	......	June 12, 1871	July 12, 1871	New York office of this company at 93 Liberty street.
A. B. Burton, for Kellog Bridge Company, 80 Broadway, New York.	......	......	......	5.6	5.2	......	......	......	......	......	July 1, 1871	July 10, 1871.	
Plant's Manufacturing Company, by A. P. Plant, president, Plantville, Hartford County, Conn.	......	......	......	6¾	......	......	......	......	......	......	August 1, 1871	Sept. 1, 1871.	
George W. Powell, Newburgh, N. Y.	......	......	......	......	......	......	2 10	......	......	......	Ship at any time at 5 days' notice.	......	Bid not accompanied by copies of specifications.
John Beattie, Stoney Creek, Conn.	......	......	......	......	......	......	......	......	3 50	......	August 1, 1871	Aug. 1, 1872	Bid informal, in not being accompanied by guaranty.
Nicholas Ball, Newport, R. I.	......	......	......	......	......	......	......	......	......	3 75	July 1, 1871	Nov. 1, 1871	Not considered, having been received at 9.45 a. m., June 7, 1871, after the bids for this work had been opened.
Henry E. Nichols, Fulton, Oswego County, N. Y.	......	......	......	......	......	......	‡2 85	......	......	......	June 15, 1871	July 15, 1871	Not considered, having been received at 11.45 a. m., June 8, 1871, the day subsequent to the lotting.

* "Upset-head."

† Per pound.

‡ No provision as to quantity.

Contracts were awarded to Messrs. Finch, Engs & Co., Newport, Rhode Island, for lumber and cement; to Messrs. R. S. Place & Co., of New York, for bolts, and to C. C. Campbell, New York, for granite.

The work of building the temporary harbor and extending the substructure is being prosecuted, and all of the funds available for this work will be expended during the fiscal year.

The estimate made by the board of engineers (see Senate Mis. Doc. No. 81, Fortieth Congress) was as follows:

Estimate of cost of breakwater for local purposes at Block Island, Rhode Island, to extend from the shore to Five-Foot or Blue-Bird Rock.

32,000 cubic yards of stone, 1½ tons to the yard, including interstices, in pieces weighing from 1¼ to 2 tons each, at $5 per yard	$160,000 00
10,000 cubic yards of facing-stone, in pieces weighing from 2 to 5 tons, at $15 per yard	150,000 00
Contingencies, 20 per cent. on cost of material	62,000 00
	372,000 00
Deduct amount of appropriation made	105,000 00
Amount necessary to complete work	267,000 00

This amount, viz, $267,000, is asked for the fiscal year ending June 30, 1873.

With the temporary harbor completed, we shall be in condition to prosecute the work with fewer interruptions from bad weather, and I think the most economical policy will be to appropriate the whole amount required to complete the work.

Block Island is in Newport collection district; the port of entry is Newport, Rhode Island. The amount of revenue collected at this port for the year ending June 30, 1871, was $3,241 69.

T 5.

SURVEY AND IMPROVEMENT OF PAWCATUCK RIVER, RHODE ISLAND AND CONNECTICUT.

The survey of this river was made in the autumn of 1870, and my report of it, dated January 17, 1871, was printed as part of H. Ex. Doc. No. 60, third session Forty-first Congress. An estimate was there submitted to make a channel 75 feet wide and 5 feet deep at mean low water, from certain draught-point up to Westerly, and a recommendation made for an appropriation of $23,000.

Congress, by the act approved March 3, 1871, appropriated $10,000 toward this object. Accordingly, on the 29th of April I advertised for proposals for dredging, but limiting the width of the channel to be dredged to a width of 50 feet. An abstract of the bids received is given below. The contract was awarded to the lowest bidder, Mr. Emory R. Seward, of Albany, New York, for 35 cents per cubic yard, which was 5 cents per cubic yard more than my estimated cost. At this rate the original estimate should be increased one-sixth, making the whole amount required $26,833. The additional appropriation required to complete the work is probably $16,833. This amount will be required during the next fiscal year, as the contract requires the completion of the work under the present appropriation by the end of October, 1871.

The contractor has not yet begun work, and there is no satisfactory explanation of his not having done so.

Pawcatuck River is partly in the Stonington, Connecticut, collection district, and this is the nearest port of entry. The revenue collected there during the fiscal year ending June 30, 1871, was $2,500. The river is also partly in the Providence, Rhode Island, collection district, where the revenue for the same period was $203,862 43.

I annex the report on the survey made last year to this report, with some corrections and additions.

Record of tide observations at Burdick's Wharf, Lottery, Rhode Island.

Date.	6 a. m.	6½ a. m.	7 a. m.	7½ a. m.	8 a. m.	8½ a. m.	9 a. m.	9½ a. m.	10 a. m.	10½ a. m.	11 a. m.	11½ a. m.	12 m.
1870. November 21	......	......	......	5.9	(h) 6.0	5.7	......	......	......	......	......	......	......
November 22	......	......	......	......	......	(h) 6.45	6.3	6.15	......	......	......	......	......
November 23	......	......	......	......	......	......	7.6	(h) 7.7	7.35	......	......	......	......
November 24	......	......	......	......	......	......	......	......	5.85	(h) 6.	5.7	......	......
November 25	......	......	......	......	......	......	......	......	......	......	6.1	(h) 6.2	5.95
November 26	......	......	......	......	......	......	......	......	......	......	......	......	(h) 6.9
November 27	3.4	3.1	(l) 3.0	......	......	......	......	......	......	......	......	......	5.7
November 28	......	......	......	+	(l) 3.5	......	......	......	......	......	......	......	5.1
November 29	......	......	......	......	3.65	3.55	3.5	(l) 3.5	3.65	3.85	4.1	4.45	4.7
November 30	......	......	......	......	3.95	3.85	3.7	3.55	3.5	(l) 3.45	3.58	3.75	4.15
December 1	......	......	......	......	4.25	4.1	4.	3.9	3.8	3.75	3.65	(l) 3.5	3.6
December 2	......	......	......	......	......	......	......	......	......	......	......	......	3.4

Date.	12½ p. m.	1 p. m.	1½ p. m.	2 p. m.	2½ p. m.	3 p. m.	3½ p. m.	4 p. m.	4½ p. m.	5 p. m.	5½ p. m.	6 p. m.	6½ p. m.
November 19	2.95	(l) 2.8	2.8	2.9	3.1	......	3.1½	......	......	......	5.1	(h) 5.1	4.9
November 20	......	......	2.5½	(l) 2.45	2.5	......	......	......	......	......	......	......	......
November 21	......	......	......	......	2.7	(l) 2.4	2.4½	......	......	......	......	......	......
November 22	......	......	......	......	......	2.9	2.7	(l) 2.5	2.6	......	......	......	......
November 23	......	......	......	......	......	3.8	3.65	3.35	(l) 3.25	3.3	......	......	......
November 24	......	......	......	......	......	......	......	......	2.7	(l) 2.5	2.6	......	......
November 25	......	......	......	......	......	......	......	......	......	......	3.1	(l) 2.8	3.0
November 26	6.85	......	......	......	......	......	......	......	......	......	3.25	3.1	(l) 2.9
November 27	(h) 5.85	5.6	......	......	......	......	......	......	......	......	......	......	......
November 28	5.4	5.65	(h) 5.7	5.6	5.45	5.15	4.95	4.9	4.65	4.35	4.15	3.95	......
November 29	4.95	5.25	5.45	5.65	(h) 5.7	5.7	5.6	5.35	5.25	4.9	......	......	......
November 30	4.35	4.65	4.9	5.15	5.4	5.45	(h) 5.45	5.45	5.25	......	......	......	......
December 1	3.65	3.8	4.0	4.2	......	......	......	......	......	......	......	......	......
December 2	(l) 3.3	3.35	3.5	3.7	3.9	4.25	......	......	......	......	......	......	......

NOTE.—Mean low water, as determined from the above observations, is 3 feet on the gauge; mean high water 6.1 feet, and the mean rise and fall of the tide 3.1 feet. From simultaneous observations made at Westerly, November 22, 24, 29, and December 3, 4 and 5, it was determined that the time of high water at the two places is about the same. The rise and fall at Westerly is about 3.1 feet. Mean ow water at Westerly is 4.5 feet below the lip of dam.

Abstract of proposals for improvement of the Pawcatuck River, Rhode Island and Connecticut, received at the Engineer Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Name and address of bidder.	Excavating, as per specifications.	Commence.	Complete.	Remarks.
Emory R. Seward, Albany, N. Y.	35 cents per cubic yard.	July 1, 1871.	June 30, 1872.	
E. A. Bill, Norwich, Conn.	50 cents per cubic yard.	July 6, 1871.	June 30, 1872.	Guarantee not filled out, and no certificate that the guarantors are responsible parties.

I certify that the above abstract is correct.

G. K. WARREN, *Major of Engineers.*

T 6.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 17, 1871.

GENERAL: I have the honor to submit the following report and accompanying map of a survey of Pawcatuck River, Connecticut and Rhode Island, below Westerly, authorized by section 2 of the act making appropriations for river and harbors, approved July 11, 1870.

The improvement needed is to dredge out a channel so as to give a depth of five feet at mean low water from "certain draw-point" up to Westerly, a distance of 5,000 yards. This requires, for a channel 75 feet wide, the excavation of 69,418 cubic yards, which, at 30 cents per cubic yard, would cost $20,824; allowing 10 per cent. for superintendence, would make the total cost $22,906.

There has been some little effort by residents to deepen this channel, but the Government has not thus far assisted them in it. At Stonington (which is at the mouth of the river) the United States in 1828, 1830, and 1834 appropriated $36,753 83 to build a pier or breakwater from the west side of the point on which the city is built. It has stood well, but it would now be more valuable if it had been built from some place further out on the point. The harbor formed is too contracted for the present wants of commerce.

The survey of Pawcatuck River I intrusted to Mr. J. H. Dager, civil engineer, assisted by Mr. Geo. H. Mann. The report of Mr. Dager, with all its accompanying papers, except the detailed calculations of material to be excavated, I submit with my report.

The map of the survey is on a scale of 1 to 5,000. I send also a copy of the map of Pawcatuck River, scale $\frac{1}{10000}$, of the United States Coast Survey, made in 1838, which gives also a resurvey of the sand-spit southeast of Stonington, made in 1855. The hydrography of this map does not extend up the river but a short distance above the town of Lottery.

Pawcatuck River is partly in the Stonington, Connecticut, collection district, and that city is the nearest port of entry. The revenue collected at Stonington in the fiscal year ending June 30, 1870, was $18,000 It is also partly in the Providence, R. I., collection district, at which place the revenue for the fiscal year ending June 30, 1870, was $205,650 58.

I recommend an appropriation of $23,000 for improving Pawcatuck River.

Yours, respectfully,

G. K. WARREN,
Major Engineers, Brevet Major General.

Brigadier General A. H. HUMPHREYS,
Chief of Engineers, U. S. A.

UNITED STATES ENGINEER OFFICE,
Newport, Rhode Island, January 12, 1871.

GENERAL: I have the honor to submit the following report on a survey of Pawcatuck River, Rhode Island and Connecticut, made during the months of November and December, 1870, agreeably to instructions received from you, dated November 15, 1870.

The authorization of this survey by Congress was obtained through the representations of the Hon. Nathan M. Dixon, M. C., on the strength of petitions of prominent citizens of Westerly and vicinity, and of other parties interested in navigation.

The object had in view was to improve the navigability of the river by opening a channel at whatever points needed, to allow the passage of vessels trading at Lottery and Westerly to said places, instead of having to be lightered at Stonington and their cargoes transported by scows or rail.

It is impossible for vessels drawing more than 2¼ feet to get above Lottery at mean low water.

The mean rise and fall of the tides here is about 3 feet. The tide observations are appended to this report.

From a preliminary examination and a conference with those interested in said improvement, it seemed that a channel of 100 feet in width, with a depth, at mean low water, of about 7 feet, would be necessary. Since completion of survey, however, it has been decided that a channel of 75 feet in width, with a depth of 5 feet at mean low water, will answer all requirements.

The present channel was opened by citizens of Westerly about twelve years ago, who expended thereon $4,200. The material removed was deposited alongside the channel, and has been gradually filling it up again. Of the extent of this work I could get no positive information.

The surveys made were a limited topographical and full hydrographical survey, extending from the bridge over Pawcatuck River, in Westerly, to Little Narraganset Bay, a distance of about six miles; and their progress was submitted to you weekly.

The surveys have been plotted to a scale of $\frac{1}{5000}$. Contours of planes of 2, 4, 6, and 12 feet below mean low water, are shown in black-dotted, green-dotted, full green, and red lines respectively.

The lines of the proposed channel are shown by straight black lines.

A profile of the center-line of the proposed channel is drawn to a scale of $\frac{1}{5000}$ horizontally and of $\frac{1}{50}$ vertically.

In order to open the proposed channel, (75 feet wide and 5 feet deep at mean low water, and giving the sides a slope of 45°,) there will have to be removed 69,413 cubic yards; which, at a cost of 30 cents per yard, would amount to $20,824, and allowing 10 per cent. for superintendence, &c., would make a sum total of $22,906.

The material to be removed consists of fine gravel and sand in about equal quantities, and a small proportion of soft mud; and can be deposited in the coves, or on any of the flats on either side of the river, at any time excepting at low water.

The dam at Westerly is about 110 feet long in the clear, being flanked on each end by a large mill. The water used by these mills for power is drawn directly from the dam. The silt brought down by the stream from above passes through the waste-ways of these mills, and is deposited gradually down stream, but is small in quantity, as the stream is generally clear water.

On consideration of facts attending, the channel proposed will keep itself open, or at least will need no attention for the next twenty years.

Westerly is the depot, both by water and rail, for nearly all the supplies consumed in living and manufactures by the residents of a large extent of country, through the valley of which flows the Pawcatuck River and tributaries, on which are a great number of mills engaged in the manufacture of cotton, woolen, and other goods.

It was impossible for me to get the percentage of articles of export and import by water, excepting coal and lumber. Nearly all of these articles are shipped by vessels to Stonington, and thence, by scows, to Westerly; this reshipment at Stonington makes an increase in the cost of coal per ton of 70 cents, and, on an average, yearly total increase in the cost of both coal and lumber of $13,000. Thus it will be seen that the increased cost of two articles alone, for two years, would pay for the proposed improvements.

In addition to this, I beg leave to submit the papers which contain the calculations for sectional excavations and total amount, prepared by Mr. George H. Mann, civil engineer.

I also submit a small printed description of Westerly and its manufactures; also, a paper containing information derived from Mr. Segar, relative to the vessels, class, value, tonnage, and draught owned by citizens of Westerly; also, a paper written by Mr. George Hubbard, collector of customs at Stonington, Connecticut, without reference to any data he may have had, and which I do not deem of much value. Also, a paper containing an estimate of imports and exports during one current year, with statistics of all vessels and shipping on Pawcatuck River.

This information was obtained from the following named persons: W. A. Burdick, agent for granite works; Batterson & Ledward, granite works; Samuel B. Segar, coal dealer; Thomas Segar, coal dealer; Samuel Cross, Rhode Island legislature; Captain Joshua Thompson, merchant; Charles Maxon & Co.; Moss & Babcock, cotton and woolen manufacturers; Cottrell & Babcock, printing-press, &c., manufacturers; Stillman Bros.; Stillman & Clark; Dudley R. Wheeler, and others engaged in the manufacturing business. I was assisted in the survey by Mr. George H. Mann, civil engineer. I also had the services of General H. A. Frink, civil engineer.

In conclusion, I think the business interests of Westerly and vicinity would call for a favorable consideration of the proposed improvements of Pawcatuck River, Rhode Island and Connecticut, by our next Congress.

I am, sir, respectfully yours,

JOHN H. DAGER,
Civil Engineer.

Major General G. K. WARREN,
Major of Engineers, U. S. A.

Extracts taken from Webb's Northeastern Railway and Manufacturers' Statistical Gazetteer for 1870.

Westerly, eighteen miles from New London, forty-four from Providence, one hundred and forty-four from New York, eighty-eight from Boston, and six from the Atlantic Ocean, at the head of navigation on the Pawcatuck River. The Indian name for this village and town is Misquamicut, located on the Stonington and Providence Railroad. The river is navigable for vessels, to the village, of 40 and 50 tons. A small steamer plies, during the summer months, between this place and Watch Hill, a famous summer resort, where are located several first-class hotels, which are liberally patronized by the citizens of our largest cities.

Westerly is a very wealthy, enterprising, and rapidly growing place, of about 5,000 inhabitants, containing four or five churches, four banks, two weekly newspapers, and one of the most substantially built, elegantly furnished hotels in the United States, erected by Babcock & Moss, a manufacturing firm of this place, and opened to the public in 1868. It is dedicated to the memory of the Dixon family, and called the "Dixon House."

MANUFACTURES.

Cottrell & Babcock, established in 1855, manufacturers of machinery in general, principally woolen machinery and printing-presses. Their machine-shop, 70 by 80, three stories; foundery, 75 by 50, one story; and blacksmith-shop, 30 by 85, one story; pattern-house, 30 by 40 feet, two stories, and store-house, 30 by 50, two stories; employ 150 men; consume 500 tons cast iron, 100 tons wrought iron, and 200,000 feet of lumber annually. This firm produced last year about $150,000 worth of goods, which were shipped to different parts of our country; also to Canada and South America. Their machinery is driven by a 45 horse-power engine.

Stillman, Bros. & Co., succeeded J. P. Stillman & Co. in 1858, who commenced in 1842. They manufacture wood-working machinery, planes, and brass roller shives. They employ 25 persons, and occupy a room 40 by 48, and another 20 by 24. Power furnished by Stillman's turbine water-wheel.

Babcock & Moss occupy two mills at Stillmanville, one-quarter mile north of the depot for the manufacture of cassimers and cottonades; one being of three stories, the other two and a half, running eight sets on cassimeres and eight on cottonades. Employing 350 persons; making 20,000 yards of cottonades and 6,000 yards of cassimeres per week; using 7,500 pounds of wool per week for cassimeres.

The machinery is driven by three of Stillman's turbine wheels, and a 90-horse Corliss engine, patent and make, using five tubular boilers, made by Hicks, of Providence.

This company also run another mill in the south part of the village, near the river, formerly occupied by Campbell & Co. It contains nine sets for cassimeres, run by a 90-horse Corliss engine and make, with six tubular boilers, making about 600 yards per week.

O. M. Stillman occupies a four-story brick mill 100 by 48, built in 1848, for the manufacture of cassimeres; employing 100 persons, running six sets of woolen machinery, and thirty-six looms, turning out 6,000 yards per week; using up 5,000 pounds of clean wool per week. The power is furnished by Stillman's turbine wheel, and a 25 horse-power engine, built by the Putnam Machine Company, of Fitchburgh, Massachusetts. The pay-roll amounts to $3,500 per month. The average wages per month for males and females, $35. This manufactory is located about one-quarter of a mile north of the depot, on the Pawcatuck River. There are also, in connection with this manufactory, two wooden buildings, two stories, each 150 by 30 and 40 by 70 feet, used for dye-house, wool-sorting, and fulling-out. The details of this concern are under the charge of J. R. Scott, superintendent.

E. &. H. Babcock commenced the manufacturing business in 1844. They now occupy two mills at Potter's Hill, built in 1847, four miles north of Westerly, one of them three stories, built of stone, 54 by 108 feet; the other three stories, built of wood, about 40 by 80 feet. They employ 110 persons manufacturing flannels, using eight sets of machinery, 100 looms, and turning out about 15,000 yards per week. The mills are run by water-power, using a United States iron water-wheel. The selling agents are Sutton, Smith & Co., No. 85 Worth street, New York. This company run a small mill at Slocumville.

White Rock Manufacturing Company.—This company occupies a mill built in 1849, at White Rock Village, one mile north of the depot, for the manufacture of roll jaconets and fine shirtings; four stories, brick, 180 by 50; employ 150 persons, running 10,000 spindles, 224 looms, using 15 bales of cotton per week, the average production being 2,700 yards per week. The motive power is furnished by a French turbine water-wheel and one United States wheel, the fall being about 8 feet. The mill is located on the Pawcatuck River, with walks tastefully laid out in front of the building; a fine grove on the grounds adds a pleasant aspect to the surroundings. A village of sixteen houses is located directly opposite. This company have taken great pride in making this place the pleasantest and neatest manufacturing village in New England, and we say that they have done so; a striking contrast with some other villages owned by less enterprising proprietors in New England. The rules of the mill are so arranged as to insure neatness and order unexcelled, and we venture to say that the finest-dressed persons can visit this manufactory and not fear of soiling their garments, as the mill is kept in perfect order in every detail. This company also run two woolen-mills in the center of the village of Westerly, one built of stone, 60 by 40 feet, three stories and attic, the other of brick, 60 by 25, five stories. They employ 45 persons in these two mills manufacturing lindseys, the weekly production being 1,680 yards.

There are six sets of cassimere machinery now standing, three of them running for 44 linsey-looms.

A new mill is now in course of erection, to be three stories high, and about 100 by 48, with a dye-house 24 by 48. This new mill is situated adjoining the other, and is designed for six sets of machinery, including 30 cassimere looms that are not now in operation. The new mill will probably be in full operation in the fall of 1869. Babcock & Moss are agents for the company.

Vessels trading on Pawcatuck River, Connecticut.

Name.	Class.	Tonnage.	Character of cargoes.	Value of cargoes.	Value of vessels.	Quantity of cargoes.
						Tons per trip.
Florence	S. tug	60			$10,000	
Belle	S. boat	188	Passengers and merchandise		23,000	
E. A. Stevens	Schooner	159	Lumber and coal	$38,000	6,000	200
Josephine	do	60	do	36,000	5,000	100
White Wing	do	100	Coal and stone	45,000	14,000	200
Maria	do	120	do	45,000	16,000	200
T. Dickens	do	50	General merchandise	75,000	3,000	75
Jane	do	55	Coal and stone	20,000	2,300	95
A. Crandall	do	55	Coal and brick	20,000	4,500	92
Susan E. Nash	do	90	Lumber and coal	50,000	10,000	140
E. W. Babcock	do	53	do	20,000	2,200	65
E. A. Chesbro	do	90	do	50,000	9,500	140
Lucy C. Hall	do	60	do	36,000	5,000	105
Harriet	do	25	General merchandise	10,000	2,000	40
Jennie	Sloop	13	do	20,000	1,600	18
Ida May	do	13	do	20,000	500	18
C. H. Smithers	do	30	Lumber, coal, and brick	18,000	2,700	40
Glide	do	30	do	18,000	2,300	40
Pettiquamscutt	do	30	Lumber	18,000	2,000	40
Madgie	do	30	Lumber, coal, and brick	18,000	2,700	40
M. M. Moore	do	25	Fish and oysters	15,000	600	30
Alvda	do	30	Brick	18,000	1,000	40
Erylyn	do	25	Lumber	15,000	2,000	30
G. B. McClellan	do	25	Brick	15,000	1,500	30

Average draught, loaded, 7¼ feet.

Forty-four transient vessels, 250 tons each; twenty-one transient vessels, 200 tons each. All were obliged to be lightered.

Estimate of freight exported from Westerly, Rhode Island, during one current year.

Description of goods.	Cases.	Tons.	Valuation.
Cotton and woolen goods	6, 825	1, 023	$2, 441, 000
Machinery	....	550	165, 000
Building materials	....	4, 500	235, 000
Granite	....	18, 150	493, 500
Total	....	24, 223	3, 334, 500

Estimate of freight received at Westerly, Rhode Island, during one current year.

	Tons.	Feet.	Bales.	Hogsheads.	Barrels.	Bushels.	Thousand.	Valuation.
Coal	14, 391	....	....	....	....	....	....	$115, 128 00
Iron	900	....	....	....	....	....	....	72, 000 00
Wood	....	....	12, 000	....	....	....	....	1, 080, 000 00
Cotton	....	....	2, 325	....	....	....	....	290, 625 00
Lumber	....	8, 500, 000	....	....	....	....	....	318, 750 00
Brick	....	....	....	....	....	....	1, 050	15, 750 00
Manufacturers' supplies	889	....	....	....	....	....	....	829, 437 00
Machinists' supplies	700	....	....	....	....	....	....	70, 000 00
Ship-builders' supplies	200	....	....	....	....	....	....	15, 000 00
Machinery	50	....	....	....	....	....	....	15, 000 00
Cement	....	....	....	....	500	....	....	1, 250 00
Lime and plaster	....	....	....	....	5, 041	....	....	17, 644 00
Fertilizers	500	....	....	....	....	....	....	25, 000 00
Flour	....	....	....	....	12, 970	....	....	116, 730 00
Sugar	....	....	....	....	1, 016	....	....	30, 480 00
Pork	....	....	....	....	324	....	....	9, 720 00
Lard	....	....	....	....	300	....	....	13, 320 00
Butter	30	....	....	....	....	....	....	24, 000 00
Molasses	....	....	....	154	....	....	....	18, 480 00
Grain and meal	....	....	....	....	....	146, 340	....	160, 974 00
Coarse salt	....	....	....	....	....	3, 500	....	2, 100 00
Apples	....	....	....	....	3, 500	....	....	10, 540 00
Kerosene oil	....	....	....	....	325	....	....	6, 500 00
General merchandise	2, 015	....	....	....	....	....	....	505, 000 00
	19, 675	8, 500, 000	14, 325	154	23, 976	149, 840	1, 050	3, 763, 428 00

From Mr. Segar.

About 12,000 tons of coal annually on road and river.
About 10,000 tons of coal annually on river.
Increase of cost per ton owing to lighterage, 70 cents per ton.
Average cost of coal for 1870, $8, from Rondout and Philadelphia.
White Bar, comparatively little obstructions.
Depth of 5 feet at low water sufficient.

	Value.	Capacity.	Draught.
		Tons.	*Feet.*
Schooner Jane	$2, 500	80	5½
Schooner Dickens	2, 500	80	5½
Schooner Crandall	2, 500	93	6
Schooner Maria	10, 000	200	7
Schooner Cheesebrough	8, 000	160	6½
Schooner Babcock	1, 500	80	5½
Sloop Mazeppa	2, 500	40	5
Sloop Madgie	2, 500	45	4
Schooner White-Wing	10, 000	185	7
Schooner Nash	7, 500	140	6½
Schooner Lucy Hare	6, 000	105	6¼
Seven lighters	3, 500	400	3
Steam-tug Florence	10, 000	25	2½
Steamer Belle	20, 000	50	3
Total	92, 000	1,783	....

Statement of vessels belonging to Westerly, Rhode Island.

17 sail-vessels, tonnage	600
2 steamers, tonnage	240
	840

There is brought to this port for the consumption of Westerly, from one and one-half to two and one-half million feet of lumber, which is discharged at Stonington, and conveyed in lighters up the river. There is also, say, some 3,000 tons or more of coals brought in their own and other vessels, part of which is reshipped here in lighters and by rail. There are also several vessel-loads of brick, molding-sand, &c. There is also a very extensive granite-quarry business done from Westerly, probably $2,000,000 shipped by vessels and rail; also a large business done in manufacturing cotton and woolen goods.

The great reason for these vessels discharging cargoes at Stonington is, in consequence of obstructions in Pawcatuck Bay and River; the first called "White Bar," with, say, from 6 to 7 feet at flood; the other is what is called Kenyan's Bar, above Pawcatuck Rock, near the cemetery. Could these obstructions be removed, it would be a very great convenience to the public of Westerly, thereby saving both in time and money.

At the present time there is probably more business done at Westerly and vicinity than all the balance of the district in manufacture, &c., department. It is a very flourishing and business community.

GEO. HUBBARD,
Collector of Customs at Stonington, Connecticut.

T 7.

Improvement of Thames River, Connecticut.

At the time of my last annual report, September 30, 1870, there was a balance on hand from previous appropriations of $556 08, which, under a wrong impression, I stated would revert to the Treasury under the act approved July 30, 1870. This amount was, however, available at that time. The act approved March 3, 1871, made an additional appropriation of $15,000.

The map of the river, from the survey that was made in June, 1870, was completed last February, on a scale of about 182 feet to the inch. This scale was taken as being an equal multiple of the original map of the river, made by Major Bache, when conducting the first works of improvement, in 1837–'38. Captain J. A. Judson, civil engineer, made this map, and he prepared a report, dated March 1, 1870, giving a history of former works of improvement as far as this office furnished records, the present condition of the river, and recommendations for further improvements. This report and the map were sent to the Engineer headquarters on the 22d of last June, but a copy of the report is now annexed to this report.

It appears, from the last survey, that there is a "middle ground" in Norwich Harbor, much in the way of certain interests at that place, but that there is a wide and deep channel on the west side of it; that then, next below, there is a shoal place in the main channel, having but 9½ feet on it at mean low tide, thereby separating the deep water opposite the middle ground from that at the "coal-yards" below; that below this there is another shoal in the channel, extending from the upper rolling-mill to and below Bushnell's Reef, that has 8¾ feet water at mean low tide; and that below this last is another set of shoals, known as the "Haycocks," where there is but 9 feet at mean low water. All these shoals are within two and a half to three miles below Norwich, and below them the channel is deep enough.

It was my intention to carry out the plan given in Captain Judson's report as estimate B. This would, according to the assumed price, (35 cents per cubic yard,) have exhausted the appropriation. It would have made a channel-way up to Norwich, having 11 feet at mean low water, and 14 feet at mean high water, with a minimum width of 100 feet. This depth was contemplated in the first plan of improvement made in 1829.

The following is the abstract of the proposals received for doing this dredging, in answer to my advertisement, on April 29, 1871:

Abstract of proposals for improving the Thames River, Connecticut, received at the Engineer Office United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and addresses of bidders.	Excavating as per specifications.	Commence.	Complete.
	Per cubic yard.		
Emory R. Seward, Albany, New York	$0 20	July 15, 1871	June 1, 1872
Edgar M. Payn, Albany, New York	22	June 15, 1871	June 30, 1872
S. F. Shortland & Brother, 106 Wall street, New York City.	24½	On or before June 30, 1871	As soon as possible.
W. H. Beard, 41 Wyckoff street, Brooklyn, New York.	25	July 1, 1871	Oct. 1, 1871
* E. A. Bill, Norwich, Connecticut	29	June 20, 1871	Dec. 30, 1871
Norris G. Dodge, Little Falls, New York	34	July 25, 1871	June 30, 1872
Morris F. Brainard, Albany, New York	39	Sept. 1, 1871	Dec. 1, 1871

* Guarantee not filled out, and no certificate that the guarantors are responsible parties.

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

The contract was awarded to the lowest bidder, Mr. Emory R. Seward, of Albany, New York, for doing the dredging, at 20 cents per cubic yard. This price is so much below that in the estimate, that the amount of work that can be done considerably exceeds that first contemplated, and it may become a question whether to make the channel-way wider than 100 feet at the shoals below the middle ground, or to widen the channel at that point.

The common council of Norwich have expressed their preference for the latter project.

The contractor has not yet commenced operations, and some indulgence should be allowed him on account of the very low rate at which he undertakes the work. The material to be dredged is easy digging, but there are no convenient places for dumping the scows, which makes this part of the work expensive.

An annual appropriation of $10,000 could be expended with much advantage to commerce in maintaining or widening and deepening the channel of the Thames River.

The appropriations made by Congress prior to 1866 amount to $40,000. General Delafield, in a report to the Secretary of War, dated February 14, 1868, says: "In 1829, before any of this expenditure was made, there was 7 feet 10½ inches depth at the shoalest point at low water."

The survey by Colonel Houston, in 1866, before any work was done under the appropriation made that year, shows a depth of 7 feet at mean low water over the shoals in the channel.

The appropriation of $10,000 in 1866 and the two appropriations of $36,000 each in 1867 were expended in dredging, and after this the survey in 1869 shows that vessels drawing 8¾ feet could reach Norwich at mean low water. General Delafield condemns the use of jettees for tidal rivers, which was the system employed before Major Bache's survey, and which the latter recommended with modifications.

General Delafield's report above referred to states that a flood-wave of from 4 feet 1 inch to 4 feet 8 inches once flowed uninterruptedly to and from the Sound to Norwich every twelve hours.

According to the map made under Colonel Houston in 1866, tide observations made during thirty-three days, at Norwich, gave a mean rise of 3 feet 1½ inches, the highest tide being 3 feet 9¼ inches. From the above we should infer the jettees cut off about 1 foot of the rise at Norwich, so that vessels could originally reach Norwich at high tide, drawing 1 foot more water than they could in 1866, and that all the dredging done under the appropriations only succeeded in allowing the same-sized vessels to reach Norwich in 1869 as could do it before any work was done. The data is not sufficient to decide the question, but it certainly suggests the propriety of investigating the matter, to determine whether it would not be desirable to remove some of the lower jettees, so as to re-establish the ancient flow of the tide. The mean rise of the tide at New London is only 2½ feet, and this makes it seem rather surprising that it could have caused originally a tide of about 4½ feet at Norwich, as stated by General Delafield. I will institute a thorough inquiry into the subject during the prosecution of the further improvement.

New London is the port of entry, and it is in the New London collection district. The revenue collected during the fiscal year ending June 30, 1871, was $54,058 54.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, March 1, 1871.

GENERAL: I have the honor to submit the following report in relation to the Thames River, Connecticut, together with a map of a portion of the river immediately below the city of Norwich, showing the results of a survey made by me in the summer of 1870. This survey had been contemplated by Colonel D. C. Houston, United States Engineers, while he was in charge, and, after his temporary relief by Captain A. H. Holgate, United States Engineers, during the month of May, 1870, that officer applied to the Engineer Department for authority to make it, which was granted in departmental letter, dated May 13, 1870. Unfavorable weather and duties here prevented anything being done until the 1st of June, when I proceeded to Norwich, and during that month prosecuted the work as the weather, much of which was unfavorable, permitted. Until this time, owing to the pressure of other duties, I have been unable to complete the office work, which I now respectfully submit.

As before remarked, Colonel Houston had intended making this survey, as will be seen in his annual report, dated August 27, 1869, printed in the report of the Chief of Engineers for that year.

The object of the survey, as intended by Colonel Houston, and expressed by Captain Holgate in his orders to me, was to ascertain the changes, if any, that had taken place in the channel of the Thames since the last dredging was done in August, 1869; to fix upon the causes thereof and the possible remedy, and, should the remaining funds admit, to apply the remedy as far as practicable. Before entering into this, however, I propose reviewing the history of this river since the first work was done on it by the General Government, believing this to be essential to a proper understanding of the subject.

From the records in this office it appears that the question of the improvement of the channel of this river was agitated many years since by the people of Norwich and others, and that in 1836 Congress appropriated $10,000, in 1837 $20,000, and in 1838 $10,000; all of which, amounting to $40,000, was expended chiefly in the construction of wing-dams or jettees at various points on either bank of the river for a distance of about three miles below the city of Norwich. These dams, their object and effect, will be alluded to further on. In 1848 an estimate was made for $10,000 for continuing the system of contemplated improvement by constructing jettees, but it failed to become a law. No further action was taken until 1866, when an act of the Thirty-ninth Congress, first session, approved June 23, 1866, appropriated the sum of $10,000 for the "improvement of Thames River, Connecticut." This was followed, in the second session of the same Congress, by two additional appropriations, each for $36,000. The first is embodied in Chapter CXLIV, entitled "An act making appropriations for the repair, preservation, and completion of certain public works heretofore commenced under the authority of law, and for other purposes," approved March 2, 1867, for "improvement of Thames River, Connecticut," for $36,000. The second is embodied in Chapter CLXVIII, entitled "An act making appropriations and to supply deficiencies in the appropriations for the service of the Government for the fiscal year ending June 30, 1867, and for other purposes," also approved March 2, 1867, and "for dredging and maintaining the channel of the river Thames, near Norwich, in the State of Connecticut, to complete the work, $36,000." The total appropriated, then, since 1866, is $82,000, and, including the former appropriations of 1836, 1837, and 1838, amount in all to the sum of $122,000, which has been expended by the United States in improving the navigation in this river, except the sum of $556 08, which was all that was available at the close of the last fiscal year, and which reverted to the Treasury of the United States, under the act approved July 12, 1870, relating to unexpended balances.

It appears from the report of General Delafield, the then Chief Engineer of the Army, to the Secretary of War, dated February 14, 1866, that "an attempt to improve the navigation of this river was in progress previous to 1829. At that time there existed four jettees, projecting from the shore toward the channel that had been constructed to deepen the channel over existing bars. At that early period the system then adopted had not succeeded, and some of the piers that had been constructed had been, in part, removed, and at the same time it was proposed to construct eleven other and additional piers, to narrow the water-way, with the hope of deepening and maintaining a permanent channel of 14 feet water," (at high water.)

A number of jettees were finally built, and are still in existence and in fair condition, and some dredging was done on the "Haycocks," a shoal shown on the map, the work being paid for from the appropriations of 1836, 1837, and 1838, already mentioned. The results obtained were for a time, and at the localities worked upon, advantageous, and the opinion prevailed that whenever the system of jettees and dredging should be fully completed, that the channel of the river could be essentially improved.

The jettees *now* possess of themselves alone a certain value, since they furnish behind them secure places of deposit for material dredged from the channel-way, either by diggers or by the scouring power due to the increased volume and velocity of which they are the undoubted aids. In the latter case it is found that most of the piers have flats below them that have been formed by eddies setting in around the piers, carrying sand and other particles that find rest in still water. Most of these flats are bare at low water. In the former case it is believed that none of the material which has from time to time been dredged from the channel and deposited below these piers has ever found its way back again. So far as they go, the jettees seem to have answered the purposes for which they were built.

Since the completion of these piers, work has been confined to dredging in the channel. Some little work was done from time to time by parties in Norwich, but it was not until the late appropriations of 1866 and 1867 became available, that the United States again took the matter in hand. In August, 1866, Colonel Houston, of the Engineers, was directed to have a survey made of the river below Norwich, with a view to the contemplated improvements. I was designated by Colonel Houston for this work. The map showing results of the survey, with the report of Colonel Houston on the subject, were both forwarded to the Department on the 19th of November, 1866. The original of the map is on file in this office, and the report referred to is printed in House Ex. Doc. No. 56, part 2, Thirty-ninth Congress, second session, pp. 197, 198. Colonel Houston's recommendations as to the mode of improvement of the river were approved by the Department in a letter of April 11, 1867. The contract made by him with Mr. E. A. Bill, of Norwich, Connecticut, requiring a channel 100 feet wide, with 14 feet at high water, was approved on the 27th of June, and dredging commenced in July, 1867, and was carried on with good results during the working seasons of that year, and of 1868, and up to August, 1869, when the appropriation being nearly exhausted, work was suspended, leaving a small sum available, part of which was expended in making the survey, of which this is the report.

The main shoals on the river that have given trouble are five in number. Their location may be understood by reference to the accompanying map. The first is the "middle ground," in front of the new wharf of the Norwich and Worcester Railroad Company. The survey of 1866, made before this wharf was built, shows a small island as a part of this great shoal, which formed below a jettee built in 1837 or thereabouts. The island and jettee were both built into the new wharf. Their line of low water is shown on the map, as it was before the construction of the new wharf, in heavy red lines. It is the generally received opinion that the material composing this island and the whole "middle ground" is foreign to the Thames, and owes its presence there to the following circumstance, an account of which I quote from Colonel Houston's report of August 6, 1866. He says:

"It seems that some years previous to the construction of these piers, a canal was cut across a bend of the Shetucket River, about four miles above Norwich, intended as a water-power, but that, by some accident, the water was allowed to pass unobstructed

many other points relating to the river, all agree in this st
in the belief that nothing of consequence has come into
tucket since that time.

The next shoal is opposite the "coal-yards." There has al
close in shore on the east side, but the bend in the channel-w
Considerable of this was cut off and the channel straightene
direction, to the great relief of navigation. Sharp cha
objectionable in this river, since almost all the vessels g
favored with a fair wind, are towed by steamer from the
London to the head of navigation at Norwich, and return in
ber of vessels of from 1 to 8. Such long lines of vessels a
tortuous channel-way. Some change has taken place her
tions in 1869, the channel having narrowed and filled fr
small amount of dredging will be needed here.

The next shoal is between "upper rolling-mill wharf," (
hood of "Bushnell Reef," and has always been the shoalest
has filled considerably since 1869.

The next shoal stretch is known as the "Haycocks," exte
below pier L to where the channel hugs the west shore belo
in fact the east boundary of "Trading Cove Flats." Thi
extent. Below this there is plenty of water, and always has
part of the river shown on the south end of the map, about th
Craig's and Whiptop Points, where a shoal spot has at times
laden vessels sometimes have touched. This, however, is now
of water for any vessels that ever come up the Thames.

This, it will be remembered, was the state of the channel la
may have taken place since then, and probably have, (tho
time they have had no spring freshet,) so that the map doe
now actually is; but if any dredging is done this season, it
a means of comparison with the survey that may be made
Changes are constantly going on in the channel, owing
causes, but, in my belief, chiefly to the presence of the "mi
valence of freshets in the Shetucket and Quinnebaug (t
Thames) in early spring. These freshets are confined princip
entering the Thames, the swollen waters carrying immense q
meet the first obstacle at the "middle ground." Colonel Ho
report of August 6, 1866, already quoted, when he says:

"The only cause now at work to injure the channel is the
the branches of the river piles up below their junction, a
which reaches to the bottom. When this mass of ice m
move the loose material at the bottom, cutting out new c
old. Within the last few years dredging has been resorted to

It may be suggested that in time this "anchor-ice" would
dle ground." Whether it would or not I am not prepared t
would; but I feel safe in stating that were this

Aside from the probabilities of preventing in this way the increment of shoals below, the removal of this shoal will be of great advantage to the city of Norwich, in affording more anchorage and harbor-room for general purposes, now much needed. It will also be of very direct advantage to the Norwich and Worcester Railroad Company, in improving the river approach to and frontage of their new wharf, and for this reason I believe that, in fairness, that corporation should share the expense equally, or, at any rate, in *some* proportion with the General Government. So long as the "middle ground" remains, they will never be able to keep a channel-way open in front of their wharf. In 1869, on the completion of this structure, the railroad company had a cutting immediately in front of it, 125 feet wide, and 14 feet deep at high water. This left a shoal, having barely 2 feet water on it at low water, between the main channel and the wharf-cut.

The line of the cut is shown on the map in a heavy blue-dotted line. In the spring of 1870 there was a heavy freshet in the Shetucket, and the result was that when the current struck the "middle ground," an eddy was formed that set in against the face of this wharf, and carried with it sufficient sand and gravel to produce the resultant filling shown by the soundings on the map, which, supposing the cut to have been thoroughly made in 1869, to the width and depth given above, (as I believe it was,) would amount to 14,120 cubic yards of filling, between that time and June, 1870.

I would therefore respectfully recommend as follows: That whenever sufficient funds are available, the "middle ground" be removed to 14 feet at high water, thus corresponding with the desired depth of the main channel, provided the railroad and steamboat companies and those directly interested in the wharf property benefited by the improvement contribute their proper share. If, however, the next appropriation made by the United States be small, I would recommend it to be expended in giving immediate relief to navigation, by dredging at the points needing the earliest attention, viz, at the "coal-yards;" on the stretch between the "upper rolling-mill wharf" and the neighborhood of "Bushnell's Reef;" and on the "Haycocks," leaving the work on the "middle ground" until more money is available, for, unless its entire removal is undertaken, no work there is necessary, there being plenty of water in the main channel to the west of it. All these cuts are indicated on the map in parallel, heavy red lines, showing a channel 100 feet wide, except at the "coal-yards," where the additional width of 100 feet is shown by a heavy, *dotted* red line. While at this point a channel of 100 feet width will perhaps answer, a 200-foot cut, as is shown on the map, would be better. This was done heretofore by Colonel Houston's direction. It seems probable that the increment here is due to the material displaced from the "middle ground" immediately above. In the estimates following, I have considered both a 100-foot and a 200-foot cut at this locality.

Estimate A.—For excavation in the Thames River, Connecticut, to obtain the following results:

1st. The removal of the "middle ground," to obtain a depth of 14 feet at mean high water, from the front of the wharf of the Norwich and Worcester Railroad Company to the main channel over the entire area—44,614 cubic yards, at 35 cents per cubic yard	$15,614 90
2d. To obtain a channel, connecting the deep-water channel west of the "middle ground" with that below the "coal-yards," 100 feet wide at some points, and 200 feet wide at others, as shown on the map, with 14 feet at mean high water—12,128 cubic yards, at 35 cents per cubic yard	4,244 80
3d. To obtain a channel from the upper rolling-mill to and beyond Bushnell's Reef, 100 feet wide and 14 feet deep at mean high water, as shown in the map—12,685 cubic yards, at 35 cents per cubic yard	4,439 75
4th. To obtain a channel from Pier K, over the Haycocks, 100 feet wide and 14 feet deep at mean high water, as shown on the map—9,334 cubic yards, at 35 cents per cubic yard	3,266 90
	27,566 35
Add for contingencies, engineering, superintendence, together with removal of sunken trees, sometimes found in the channel and not detected in the surveys, say 20 per centum	5,513 27
Total	33,079 62

Estimate B.—For excavation in the Thames River, Connecticut, to obtain the following results:

1st. To obtain a channel, connecting the deep-water channel west of the "middle ground" with that below the "coal-yards," 100 feet wide at some points, and 200 feet wide at others, as shown on the map, with 14 *feet at mean high* water—12,128 cubic yards, at 35 cents per cubic yard	$4,244 80

2d. To obtain a channel from the upper rolling-mill to and beyond Bushnell's Reef, 100 feet wide and 14 feet deep at mean high water, as shown on the map—12,685 cubic yards, at 35 cents per cubic yard	$4,439 75
3d. To obtain a channel from Pier K, over the Haycocks, 100 feet wide and 14 feet deep at mean high water, as shown on the map—9,334 cubic yards, at 35 cents per cubic yard	3,266 90
Add for contingencies, engineering, superintendence, together with removal of sunken trees, sometimes found in the channel and not detected in the surveys, say 20 per centum	2,390 29
Total	14,341 74

Estimate C.—For excavation in the Thames River, Connecticut, to obtain the followresults:

1st. To obtain a channel, connecting the deep-water channel west of the middle ground with that below the coal yards, 100 feet wide, with 14 feet water at mean high water, as shown on the map between the the two *full* red parallel lines—2,581 cubic yards, at 35 cents per cubic yard	$903 35
2d. To obtain a channel from the Upper Rolling Mill to and beyond Bushnell's Reef, 100 feet wide and 14 feet deep at mean high water, as shown on the map—12,685 cubic yards, at 35 cents per cubic yard	4,439 75
3d. To obtain a channel from Pier K, over the Haycocks, 100 feet wide and 14 feet deep at mean high water, as shown on the map—9,334 cubic yards, at 35 cents per cubic yard	3,266 90
	8,610 00
Add for contingencies, &c., as before, say 20 per centum	1,722 00
Total	10,332 00

The contract price, under the contract made in 1867, for work on the Thames, and afterward continued at the same rate, by special authority of the Engineer Department, until the close of the work in August, 1869, was at the rate of 45 cents per cubic yard. It is thought, judging from similar work in this district, that at this time the same work could be done for 35 cents per yard, and perhaps even less; but supposing it could not be done for less than the original rate of 45 cents, then the foregoing estimates for the same amount of work will stand as follows:

Estimate marked A:	
78,761 cubic yards, at 45 cents per cubic yard	$35,442 45
Add 20 per centum, as before	7,088 49
Total	42,530 94

Estimate marked B:	
34,147 cubic yards, at 45 cents per cubic yard	$15,366 15
Add 20 per centum, as before	3,073 23
Total	18,439 38

Estimate marked C:	
24,600 cubic yards, at 45 cents per cubic yard	$11,070 00
Add 20 per centum, as before	2,214 00
Total	13,284 00

The place in which to deposit excavated material demands careful consideration.

First. As regards the middle grounds, the new wharf of the Norwich and Worcester Railroad Company was filled in partly from material excavated from the trench or cut made in front of their wharf, and partly from stone, earth, &c., brought up by cars from along the line of adjacent railroad. There is still considerable filling needed to complete and properly grade the wharf, which could not be more conveniently supplied than from this shoal immediately in its front. Should there be more than is needed, it can be safely deposited anywhere to the east and south of the Pier B, where much material from the neighborhood has already been placed. If this latter were done, it is understood the railroad company would make efforts to wharf it in and thus secure it.

The material taken out in front of the coal yards can also be deposited at the place above indicated, or, if there be not room enough, can be placed either on Kinney's Flats, within the line of Pier D, or taken down the river below either the Upper Rolling Mill wharf, the Lower Rolling Mill wharf, (Pier G,) or below the Sand Pier, (so called,) Pier H. At any of these locations, too, can the material excavated between the Upper Rolling Mill and Perch Rock be placed with security.

The excavations from the Haycocks can be placed on the Trading Cove Flats, there being an inshore channel sufficient for scows following the west shore northward from the neighborhood of Cooper's Point.

From time to time dumps have been made in all these localities, and it is believed none of the material has moved back into the channel. Further observation may indicate other and perhaps better places of deposit, perhaps below piers N and M, though at these two places there are oyster fields or beds, which, unless it is absolutely necessary, ought not to be interfered with.

Further examination may show that the line of cutting may, with benefit, vary from the direction I have laid down on the map. As, for instance, it has been suggested that the channel be straightened from the head of Pier G to Bushnell's Reef, and that that across the Haycocks should be perfectly straight from the head of pier K to the point on the west shore where the channel takes the next natural bend. These schemes may be of doubtful utility. If, however, the middle ground is to be removed I would recommend that no deviation be made from the present line of deepest water until time shall have shown what effect this alteration in the upper bed of the stream will have.

The mode of survey adopted was as follows: The heads of piers, the shore-line, the wharves, and prominent points had been carefully located in the transit survey of 1866, and remaining substantially the same, were used as the main objective points of this survey. Any subsequent changes in the shore-line since then were noted. I procured a quantity of fine white cod-line, which neither stretches nor shrinks materially, and marked it with white tags every 10 feet, the fifties and hundreds being marked, respectively, with red and blue tags to facilitate counting. Ranges of stakes (rough spruce scantling) were then driven in shoal places convenient distances apart, on known lines referred to known points, generally parallel to the direction of the channel Parallel to this line, another range of stakes, equally distant apart, were also placed. The graduated line was then stretched across the channel from stake to stake, and soundings taken from a small boat opposite each tag, thus giving series of soundings, 10 feet apart, at right-angles to the general direction of the channel, the lines being sufficiently near each other to enable intelligible contours to be drawn. The soundings, as plotted on the map, are generally 20 feet apart, except on the middle ground and in occasional places, where it being desirable to show the bottom more in detail, they are given 10 feet apart. The time of tide was noted, for each sounding, and these reduced to the plane of mean low water through the medium of tide-gauges established at intervals on the river, and all referred to the bench-mark of the survey of 1866. This bench-mark (mean low water) is a cut on a pile in the corner of the wharf west of the railroad bridge across the Shetucket river, and its position is indicated on the map by a red star within a circle, thus ⊙. This point should be referred to the city grade level or the water table of some permanent structure. I intended to have done so, but by some means it was forgotten.

The level of mean low water, to which these soundings are reduced, was determined in 1866 from a register of the tides kept during thirty-three days, the average high tide recorded being 3.124 feet *above;* the lowest tide, 0.854 feet *below;* and the highest tide 3.77 feet above the determined plane of mean low water. This plane was fixed by a comparison of the average of the recorded high waters and low waters above and below the assumed plane, which resulted in a minus correction of .124 feet below that plane. The bench-mark so obtained was cut into the pile already described.

This mode of locating soundings by means of a graduated line is a very excellent one when the lines to be run are not too long and the current not too swift. I found, by attaching cork floats, such as are used on fishing nets, say every 50 to 100 feet, there was no difficulty in maintaining the line in a straight direction, even in swift running water. When the starting points are properly located this system gives excellent results. The character of the bottom has much to do with its execution, since, unless the bottom be such as to admit stakes being driven, (unless the river is very narrow,) it cannot be done. The bottom of the Thames, however, being composed chiefly of sand, with some mud and gravel, ("easy digging,") little trouble is experienced. The location of soundings with two instruments is, in some respect, a better method, but, as I had no transit observers with me in this work, it could not be done in this manner. I was assisted, however, in the survey by Mr. Joseph H. Lovel, of Norwich, Connecticut, who, since the work was begun in 1867, has been employed as inspector of dredging. His intelligence and knowledge of the river have rendered his services at all times of much value.

The commercial *importance* of this river is increasing yearly. It is the natural *outlet for the productions* of an immense manufacturing district, and the natural inlet for the foreign importations and coastwise trade, both of which are extensive and extending. The nearest port of entry is New London, in the third collection district of Connecticut, where the amount of revenue collected for the year ending June 30, 1866, was $26,662 97, and for the year ending June 30, 1870, was $60,410 67, showing an increase of $33,747 70, which is undoubtedly owing, in a great measure, to the increased facilities to navigation already afforded in the work done since 1866 by the United States.

Norwich itself is an active, enterprising city, largely engaged in manufactures, and rapidly increasing in wealth, size, and importance. Money spent by the United States in aid of the commercial interests and industrial pursuits of so thrifty a region must ultimately redound to the benefit of the country at large.

I am, general, very respectfully, your obedient servant,

H. A. JUDSON,
Assistant Engineer in charge of Survey.

Bvt. Maj. Gen. G. K. WARREN,
Major of Engineers, United States Army.

T 8.

IMPROVEMENT OF THE CONNECTICUT RIVER.

The condition of this improvement up to September 30, 1870, is given in my annual report of last year. (See Report of Chief of Engineers in Annual Document, pp. 446, 447, 448.)

The act appropriating $40,000, under which work was then being conducted, approved July 11, 1870, did not specify any particular points at which the money should be expended, but there was an understanding among members of Congress that but $20,000 of this amount was to be expended below Hartford. The appropriation act for rivers and harbors, approved March 3, 1871, made a distinction between these two sections of the river, and appropriated $35,000 for continuing the improvement below Hartford, with a separate sum for the river above Hartford and below Holyoke.

Advertisements were duly made, in 1870, for proposals to do the work under the first $20,000, as reported in my last annual report. The dredging was awarded to the Albany Dredging Company, and the piling at Hartford Bar to Mr. Emory R. Seward, of Albany. The Albany Dredging Company executed their work within the fiscal year, and the work performed by them was as follows:

Excavating and removing from bar above Mouse Island 35,077 cubic yards; excavating and removing from Pistol Point Bar 16,418 cubic yards; excavating and removing from Pratt's Ferry 12,046 cubic yards; making a total of 63,541 cubic yards, at 18¾ cents a yard, $11,955 08.

Maps accompanying this report will show the places where this dredging has been done.*

Mr. Seward failed to execute his contract for the piling at Hartford Bar, and it was advertised for again, as will be seen in the abstract of proposals given further on, but no offer was made for doing this work as low as that agreed upon with Mr. Seward, and upon his signifying his willingness to go on with the work if the time of his contract was extended, the time was extended and the work is at this date in progress.

The money from the appropriation of $40,000, approved July 11, 1870, is still on hand to pay for this work.

The matter of the $20,000, in the act approved July 11, 1870, understood by the members of Congress to be intended for the Connecticut

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* These, if not received from General Ellis in time to forward with this report, will be sent afterward.

River above Hartford, and by some of them to be for the river in the State of Massachusetts, remained undetermined until the 16th of December, 1870, when it was decided that it might be expended in improving the Connecticut River above Hartford, beginning at that place and working upward. A survey was at once begun to determine a suitable plan of improvement.

The report and maps made under my direction by General Ellis, civil engineer, were completed and submitted to the engineer headquarters on the 15th of March, 1871. This report from me and that of General Ellis, dated March 4, 1871, are annexed to this report. The plan of improvement was to construct wing-dams at five places between Hartford and the Enfield Rapids.

Further information concerning these can be got from those reports, and from the copy of the advertisement which follows.

On the 29th of April, I issued advertisements for proposals under the last appropriation of $35,000 for improvements below Hartford, and for that under the $20,000 of the first appropriation to be applied above Hartford. I have reserved advertising for proposals under the appropriation of $20,000 for improving the river above Hartford and below Holyoke until the survey now being made at the Enfield Rapids is completed.

Abstract of proposals for the improvement of the Connecticut River, received at the Engineer Office United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and addresses of bidders.	Dredging at sections named in specifications.										Piling at Hartford Bar.	Wing-dams.		Chester Rock.	Commence.	Complete.
	Hartford Bar.	Between Hartford Bar and Pratt's Ferry.	Clay Banks.	Pratt's Ferry Bar.	Between Pratt's Ferry and South Glastonbury.		Glastonbury Piers.		Pistol Point Bar.			Measured in dams.	Measured in scows.			
		Loose rock.	Loose rock.	Sand, &c.	Sand, &c.	Loose rock.	Sand, &c.	Loose rock.	Sand, &c.	Loose rock.						
	Pr.c.yd.	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*		*Pr.c.yd.*	*Pr.c.yd.*	*Pr.c.yd.*	1871	1871
Morris F. Brainard, Albany, N. Y.	$0 19	$0 60	$0 60	$0 19	$0 19	$0 60	$0 19	$0 60	$0 19	$0 60					June 15	Nov. 1
P. W. Myers, Stamford, Fairfield County, Conn. *a*	20	50	40	20	20	20			20	20					July 1	Oct. 1
W. H. Beard, 41 Wyckoff street, Brooklyn, N. Y.	23½	24	24	23½	23½	23½	23½	23½	23½	23½					July 1	Nov. 15
Emory R. Seward, Albany, N. Y.	24	30	30		24	30	24	30	24	30					July 1	1872 June 1
C. C. Campbell, 104 and 106 John street, New York. *b*	25	75	75	25	25	75	25	75	25	75	*c*$6 70	$4 20			July 1	Jan. 1
W. M. Tebo, 16 South street, New York.	30	30	30	30	30	30	30	30	30	30					July 1	
H. C. Douglass & Co., Windsor Locks, Hartford County, Conn. *d*		35	35		35	35		35		35					July 1	
Bartow M. Douglass, Hartford, Conn.		36	36			36		36		36		4 90	$4 10		July 1	June 1
Orville S. Douglass, Suffield, Hartford County, Conn. *e*	26											5 00	4 00		*f*	*f*
C. McClellan & Son, Springfield, Mass. *g*												2 40				
Albert Blaisdell, post office box 67, Charlestown, Mass.												2 90		$24 00	June 20	1871 Oct. 30
Emory R. Seward, Albany, N. Y.												4 00			July 1	Nov. 1
D. V. Howell, 141 Chambers street, New York.												6 85			July 20	Nov. 1
W. D. Daisley, 18 Haynes street, Boston, Mass. *h*														20 00	July 1	Nov. 1

Eugene Sullivan, 53 Long Wharf, Boston, Mass.														*j*21 00	July 1	Dec. 1
George W. Towsend, 22 State street, Boston, Mass. *k*														22 00	June 20	Dec. 1
T. P. Richardson, 23 South street, New York.											*c*7 25				July 1	Aug. 20
John McClay & Son, Hartford, Hartford County, Conn.											*c*7 50				Aug. 15	*l*
Tank & Ingerson, New London, New London County, Conn. *m*												2 25			July 10	1872 Jan. 1
Loyd E. Baldwin, agent Connecticut River Quarry Company, East Windsor, Hartford County, Conn. *n*												5 07	3 90		June 15	1871 Dec. 10

a Bid informal, in that, that guarantee is only filled out in part.
b Bid informal, in not being in duplicate, no guarantee, and not accompanied by specifications.
c Each.
d Bid informal, in not being in duplicate, and not accompanied by specifications.
e Bid informal, in not being in duplicate.
f The work to be subject to stage of water in the river, and it is, at times, extremely low, and at others extremely high, when there can be nothing done.
g Bid informal, bid and guarantee having been received by telegraph.
h Bid informal, in not having the requisite certificate of responsibility of guarantors.
i Measured by weight.
j Measured by weight on dock of vessel.
k Bid informal, in that it has no certificate of responsibility of guarantors, and is not accompanied by copies of specifications.
l On or before the close of navigation in 1871.
m Not considered, it having been received at 9.50 a. m., Wednesday, June 7, 1871.
n Not considered, it having been received at 11.45 a. m., Wednesday, June 7, 1871, after the bids had been opened; bid informal, in not being in duplicate.

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

From the foregoing proposals the contract was awarded to Morris F. Brainard, of Albany, New York, (Albany Dredging Company,) for the dredging below Hartford, and to W. D. Darsley, of Boston, Massachusetts, the contract for removing Chester Rock. The contract for building the wing-dams above Hartford was awarded to C. McClellan & Son, Springfield, Massachusetts.

They are at this time all at work upon their several contracts. McClellan & Son are now engaged on the bar just below the mouth of the Scantic River, where some interesting questions have arisen in regard to the ferry rights at East Windsor.

Mr. Brainard has already removed material under the last contract as follows:

At Hartford Bar, 28,125 cubic yards; at Clay Banks, 3,393 cubic yards; at Pratt's Ferry Bar, 5,967 cubic yards; at Old Pier No. 1, 3,049 cubic yards.

The amount originally estimated, made by General Ellis, for improving the Connecticut River below Hartford, exclusive of the bar at the mouth, (see document accompanying President's annual message for 1868,) was $53,310, which has now been all appropriated, and much of the benefit, if not all, expected from it, will have been realized when this amount has been expended. It is probable that considerable dredging on the bars will have to be continued annually, and an appropriation of $20,000 for the next fiscal year is recommended for the river below Hartford. The improvement of the bar at the mouth of the river is, in my opinion, a work of magnitude, and I regard a thorough survey of it as a necessary preliminary to fixing upon a plan. For this I would ask an appropriation of $3,000.

The Connecticut River below Hartford is in the Middletown, Connecticut, district, and this place is a port of entry.

The revenue collected there during the fiscal year ending June 30, 1871, was $13,664 79.

CONNECTICUT RIVER.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, March 15, 1871.

GENERAL: I have the honor to submit the following report and plan of operations for the improvement of the Connecticut River above Hartford:

As you are aware, there was in section 2 of the act making appropriations for the improvement of rivers and harbors, approved July 11, 1870, the item "For improvement of the Connecticut River, $40,000."

Shortly after the passage of this act you were informed orally, and on the 17th of August in writing, by the Hon. Philetus Sawyer, as follows: that "The agreement of the members of the States that were interested was that $20,000 should be expended in the State of Massachusetts, and the balance in the State of Connecticut. I am pledged to the above agreement, and hope it will be carried out as the Committee on Commerce understood it."

The previous survey of the Connecticut River, and plan of improvement submitted to Congress, made by Colonel Houston in 1868, was confined to the part of the river below Hartford, and as no plan had been made for improvement above Hartford, nor in the State of Massachusetts, we were compelled to commence work in the season of 1870 below Hartford, limiting our plan for the year to an expenditure of $20,000.

A little investigation showed that the idea of improvement which would jump the space between Hartford and the boundary of Massachusetts and begin work in this State must have arisen from some misapprehension.

The navigation, as it is between Hartford and the Massachusetts boundary, is so bad that any improvement above, while this part remains the same, would be nearly useless. I therefore addressed a letter to the Hon. S. W. Kellogg, member of Congress from Connecticut, requesting him to confer with the other members of Congress interested in the improvement, and inform you whether the understanding was not that the improvement should be made by expending half the appropriation of $40,000 above Hartford, and half below.

On the 19th of December, 1870, I received a communication from you, dated December 16, stating that the former restrictions upon the appropriation were withdrawn, and that I was "authorized to expend it, or as much of it as you (I) deem necessary, above Hartford."

Accordingly, on the 20th of December, I gave orders to General Theodore G. Ellis, civil engineer, (my assistant in charge of the improvement of the Connecticut River,) to make a report on the navigability of the Connecticut River as far up as the north boundary of Massachusetts, and survey such parts above Hartford as it was best to improve with the $20,000.

This work was prosecuted under General Ellis during the severe winter weather of January and February last. His report, dated March 4, is submitted herewith, accompanied by four detail maps of parts of the river between Hartford and Windsor Locks, and a general map of the river from Hartford, Connecticut, to North Hadley, Massachusetts.

The obstructions between Hartford and Windsor Locks are sand-bars of the kind belonging to non-tidal rivers, (viz, where the current is always down stream,) and, in this respect, differ from those below Hartford, where there is generally a flood tide and up-stream current twice a day.

General Ellis's plan of improvement contemplates the use of wing-dams of stone, to be 2½ feet above low water, 3 feet wide on top, with slopes of 45° on each side.

They are to be located as follows:

At Higley's Point, 600 cubic yards of stone, at $3	$1,800
At Barber's Landing, 900 cubic yards of stone, at $3	2,700
At Tunxis River, 700 cubic yards of stone, at $3	2,100
At Strong's Island, 560 cubic yards of stone, at $3	1,680
At Scantic River, 2,880 cubic yards of stone, at $3	8,640
Total	16,920
He estimates that $80 will be required to remove stumps, and about $3,000 for the survey made	3,080
	20,000

I approve the plan proposed by General Ellis, using brush to mix with the stone, to act as a bond and prevent the stone from being washed away or sinking too readily into the sand, if it is required.

The thorough improvement of the river between Hartford and Windsor Locks will probably require, in addition to the $20,000, all that has been appropriated for the ensuing fiscal year, in order to extend the dams, repair and strengthen them.

The object of the wing-dams is to concentrate the volume of water in low stages and to provide secure places, behind which the material moved along at high water can find safe and permanent lodgment.

In my opinion, no attempt should be made to improve the river above Windsor Locks (or Enfield Rapids) until good navigation is secured up to that place. The improvement of the passage of the Enfield Rapids will then be worthy of consideration.

General Ellis discusses the subject in consequence of my having referred to him the letter of Mr. Charles Buell, of Springfield, referred by you to me last month.

General Ellis thinks the dam and necessary locks would cost not less than $850,000.

In connection with this method of improvement, we must also consider the propriety of increasing the capacity of the Windsor Locks Canal, (which is about 5 miles long,) and it may be cheaper for the United States to do this, and extinguish the title of the existing canal and water-power company, than build a dam and locks for the sake of obtaining free navigation.

From the foregoing it is evident that the question of making free navigation around the Enfield Rapids cannot be contemplated by Congress in the small appropriation it has made, and I do not even feel justified in recommending the expenditure required to thoroughly investigate the different plans that might be proposed for improving the navigation at these rapids until Congress shall take some action in regard to it.

Above the Enfield Rapids, good navigation exists up to Springfield, a distance of eight miles. By slight improvement and the putting of draws in the bridges, good navigation could be had to Holyoke, ten miles further.

Holyoke is at present the head of navigation. Here another serious rapid has to be passed, and a thorough improvement for navigation would cost several hundred thousand dollars.

At Miller's Falls, about thirty-two miles above Holyoke, is another obstruction, around which there was formerly a canal, which has ceased to be used since the railroad was built. Formerly, light-draught boats, at certain stages of the river, passed up it entirely through Massachusetts.

The distance from Hartford to Windsor Locks is about eleven miles. I propose to build the wing-dams by contract, and if the plans submitted meet with your approval, will advertise for proposals at once.

Yours, respectfully,

G. K. WARREN,
Major of Engineers, &c., Brevet Major General.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers United States Army.

T 9.

IMPROVEMENT OF CONNECTICUT RIVER ABOVE HARTFORD AND BELOW HOLYOKE.

The act of Congress approved March 3, 1871, appropriated the amount of $20,000. Under the appropriation of $40,000 for improving Connecticut River, approved July 11, 1870, there was $20,000 set aside for improvement between Hartford and Holyoke, a description of the application of which has already been given under the heading, "Improvement of Connecticut River." I would refer also to the report accompanying it of myself and General Ellis for the general features of the Connecticut River in the part for which this special appropriation is made. Some persons, citizens of Springfield, Massachusetts, have expressed it as their opinion that it was useless to expend money on the river above Hartford unless the Endfield Rapids are improved, because all navigation is stopped there, except through the insufficient canal around them, and, in using this, there is an onerous toll to pay, while some others, living at Windsor Locks, at the foot of the Endfield Rapids, are of the opinion that Congress never contemplated any improvement of these rapids in the recent appropriation, and the small amount appropriated seems, in a measure, to sustain this last view. Mr. Beatty, the city engineer of Springfield, has expressed himself that the improvement could be made "with a very small expenditure, so that stern-wheelers and barges can pass direct to Holyoke without passing through the canal." I believe he contemplated a dam and lock, but did not state the probable cost. I have thought it best, therefore, to have a thorough survey made and plan devised, with proper estimate of cost. This is now going on, and will be the subject of a special report.

The nearest port of entry is Middletown, Connecticut, and the revenue collected there in the year ending June 30, 1871, amounted to $13,664 79.

HARTFORD, CONNECTICUT,
March 4, 1871.

GENERAL: In conformity with your letter of December 20, 1870, regarding work to be done on the Connecticut River above Hartford, I beg leave to submit the following report:

A general reconnaissance of the river above Hartford shows that it has been, in former times, navigable for boats of light draught at certain stages of the water, even as far up as the States of Vermont and New Hampshire. This was accomplished by means of canals around the Enfield Falls and rapids, extending from eleven to sixteen miles above Hartford, at South Hadley Falls, about thirty-four miles, and at Miller's Falls, near Greenfield, Massachusetts, about sixty-six miles, by the river, above Hartford. Since the construction of the railways in the Connecticut Valley, however, the canals above Springfield have fallen into disuse, and there is now no navigation above the village of Holyoke, Massachusetts.

At this place the bed of the canal still remains, being mostly excavated in the solid rock, but the locks and gates have long since disappeared, leaving a succession of falls in the bed of the canal.

The Holyoke Water Power Company, in their new dam recently completed, have constructed a lock of about 15 feet width at the east end of the dam, where the canal now commences, so that it is possible to repair it for use, although the great expense of the work would not be at all warranted by the amount of trade that would be likely to pass through it.

A paper-mill is now built directly over the bed of the canal, but the archway could be raised sufficiently for the passage of boats. This canal is at present used only as a tail-race for the mills along its border.

Holyoke is now, and likely to continue for many years, the head of all navigation on the Connecticut River.

Between Holyoke and Springfield, a distance of about ten miles, it is said that there are some bad places, but that boats drawing 4 or 5 feet can pass at an ordinary low stage of the water.

A line of soundings run from Springfield to Holyoke does not show anything less than 5 feet in depth at low water in the channel. On this part of the river there are two bridges, neither of which has a draw, but they are sufficiently high to allow boats without masts to pass under them.

From Springfield to Enfield Falls, a distance of about eight miles, the river is comparatively good, being mostly over 8 or 9 feet deep, with but one bar of any importance, at Long Meadow Flats. On this there is about 5 feet at low water, as sounded through the ice the past winter.

A line of soundings has been run from the head of the Windsor Locks Canal to Springfield, following as nearly as possible the line of the channel, and this was the worst place found.

Immediately at the head of the canal there is a shoal of small extent, caused by the current setting into the entrance, which has not been surveyed, as it is probable that when the channel below is improved the canal company will take care of that as well as the bed of the canal.

At Springfield there are two bridges, neither of which have draws, and there are no others down to the Enfield Dam and the head of the canal.

The Windsor Locks Canal, reaching from above the dam around Enfield Falls and the rapids below, a distance of five miles, is mostly used, at the present time, as a water-power for manufacturing purposes at the village of Windsor Locks.

The bed of the canal at the surface of the water is from 50 to 100 feet wide, and the water is from 5 to 12 feet in depth. There is an entrance lock at the upper end 77½ feet long and 20 feet wide, and at the lower end there are three locks, each 77 feet long and 18½ feet wide. All of these locks are in poor repair. The canal is somewhat filled in by washing from the banks, and is much troubled by a long eel-grass growing up from the bottom. It can, however, be put in passable condition with little expense. This will probably be done by the company when the channel is improved below. During eight weeks last summer no boats were able to get up as far as the canal on account of the low state of the river.

Although there is a fall of about 25 feet in the five miles of river alongside the canal, it is navigable at certain stages of the water, an opening being left in the middle of the Enfield Dam to allow boats to pass.

By the way of the river, boats are obliged to pass under the highway bridge at Enfield, and the bridge of the New Haven, Hartford and Springfield Railway, which also have spans over the canal. These bridges have no draws, although the charter of the railroad company requires them to have one. The railroad bridge has a "draw-span," where it was intended that a draw should be placed, but it is near the west end of the bridge, and not over the channel, which runs near the middle of the river. Between the lower outlet of the Windsor Locks Canal and Hartford are, at present, the worst places in the navigable portion of the river. By measurements taken while descending the river in a small boat, during the lowest water last summer, the depth of water on the bars in the course of the channel, indicated by the captain of a boat navigating this portion of the river who accompanied me, was as follows: At Barber's Landing, 1 foot; at Farmington or Tunxis River, 1.5 feet; at Strong's Island, 1.3 feet; at Scantic River, 1.2 feet. The deepest places on the bars were probably not found.

SURVEYS.

In view of the amount of the appropriation for this part of the Connecticut River, it was thought best not to make any extended or expensive surveys, but to give especial attention to that part of the channel which presented the greatest obstacles, and which seemed to be in the most immediate need of improvement. The worst part of the river being between Hartford and Windsor Locks, it seemed advisable to commence with the improvements at Hartford, and improve the channel upward as far as the appropriation would allow; especially as the lower part must be passed to reach the upper, and while the obstructions existed below, there was no navigation at all on the better portion of the river above.

It has also been deemed preferable to make a moderate improvement in all the worst places below the canal, so as to permit the passage of boats of light draught at all stages of the water, rather than to expend too much upon any one place; so that whatever improvements are made with the present appropriation will benefit the whole river above.

In conformity with these views, surveys have been made on the lower part of the river during the past winter, since January 1, to determine the position of the bars and the best method of improving the channel.

On the maps herewith presented, the soundings are reduced to a uniformly inclined surface between the low-water mark at Hartford, which is assumed at the zero of the gauge-board at the toll-bridge, and what is supposed to be the low-water mark at the mouth of the Scantic River, near the village of East Windsor Hill.

Bench-marks were established at intervals, and all soundings referred to gauge-stakes set from the bench-marks.

These benches were carefully leveled over between Scantic River and the gauge-board at Hartford. The height of the water at each end of the line was taken every ten minutes on three different days, to get the average slope of the water-surface, and to eliminate the effect of fluctuations of the river, which, fortunately, during the observations, were very small.

The average of the observations for a mean height of water of 2.64 feet at Hartford, varying between 2.41 and 2.97 feet, gave the slope of the river-surface between the two points at 3.10 feet, with a probable error of ±.06 feet. The total distance by the river between the points observed is 38,300 feet.

The slope of the surface at extreme low water has been assumed, however, at 3.83 feet between the above-named points, or 0.1 of a foot in 1,000 feet, as extreme low water at Hartford is caused by uncommonly low tides, which materially increase the slope of the river at such times, there being little or no tide at the mouth of the Scantic, and sometimes a foot and a half at Hartford. It is believed that the plane assumed is as near as possible to extreme low-water mark over the portion of the river where soundings were taken. The presence of the ice on the surface of the water during the time of the surveys, by its retarding influence upon the upper stratum of water, has the effect probably of deepening the channel over the worst places on the bars by increasing the current on the bottom, but the stage of the river having been at about the level of ordinary low water during the progress of the surveys, the change has not probably been material.

CHARACTER OF THE BOTTOM AND BANKS.

The bottom of the river upon the parts where soundings were taken is coarse and fine sand, with a mixture of mud in the deeper places.

Upon the crests of the bars it is a fine clear material, which moves easily, and the grains of which roll over and over each other with the current, forming small waves on the surface of the bottom, until the grains reach the top or crest of the bar, when they fall down the steeply-inclined slope of the lower side of the ridge.

This is the operation at low water: at high water the bars are probably carried away, to be reformed again as the river falls to its low level.

The character of the bars above Hartford differs materially from that of those below. The latter lie square across the river, with the deepest water above and below them in almost the same line, and crossing the deepest point of the bar. Above Hartford the bars are less compact, and their formation is more up and down, diagonally across the river, with the deep water extending into each acute angle formed with the banks.

The channel runs down on one side, between the bar and the shore, until the greater part of the water is wasted over the shoal, and forms another channel on the other side, which again has deep water, and usually continues for some distance down stream.

The general principle adopted for improving the navigation over these bars is, not so much to direct the water flowing in the channel as to cut off the wastage over the upper part of the shoal by suitable wing-dams, so as to force more water into the proper and natural channel, to enable it to scour out deeper by the increased abrasion of the water on the bottom.

The character of the banks could not well be observed during the progress of the survey, owing to the great amount of snow; but from previous observation, they are known to be washing away on the outside of the bend, for about two miles above Hartford, and to be tolerably permanent above that point.

HIGLEY'S POINT BAR. (Sheet No. 1.)

The first place above Hartford needing immediate improvement is at Higley's Point, about one mile and three-quarters above the toll-bridge.

Here it is proposed to construct a wing-dam, about 900 feet long, out from the east bank, just above the entrance of a small stream, as shown by a red line on chart No. 1, herewith submitted.

This, it is believed, will throw sufficient water into the channel to preserve the requisite depth at low water for the ordinary traffic.

BAR AT BARBER'S LANDING. (Sheet No. 2.)

The next place above Higley's Point that needs attention is near Barber's Landing, three and two-thirds miles above Hartford. This bar is of the same general character as that at Higley's Point; being formed by the wasting of the water over the flat above, and crossing to the other side of the river. Here it is proposed to construct a wing-dam, about 900 feet in length, extending out from the east side of the river below the entrance of the small stream, in the position indicated by the red line on chart No. 2, herewith submitted. This wing-dam might, perhaps, be moved a little farther down stream, but it would come in deeper water and be, therefore, more expensive.

TUNXIS RIVER BAR. (Sheet No. 3.)

Where the Tunxis or Farmington River enters the Connecticut, five and one-half miles above Hartford, two extensive sand-flats have formed; one on the west side of the river, extending from the Tunxis about three-quarters of a mile up the river, and the other below on the opposite side, extending down the river about half a mile. Between these two flats the bar has formed, reaching diagonally across the channel in the usual manner, before described.

This bar is shown on chart No. 3, and the sand-flats on charts Nos. 3 and 4, which are continuous and join on the line *a b*.

Just below the mouth of the Tunxis, the channel makes an abrupt turn to the westward, and continues down on the west side of the river with quite deep water. The bar runs for some distance between two deep pockets, and it is a matter of some doubt where it is better to deepen the channel across it. The position selected for a wing-dam at this place, shown by the red line on chart No. 3, extending out from the east bank nearly at right angles, is believed to be the best, as it changes as little as possible the present line of deepest water over the bar. This wing-dam will be about 500 feet long.

STRONG'S ISLAND BAR. (Sheet No. 4.)

At Strong's Island, so called, although at ordinary low water it is all covered, the principal bar is situated just below the flat or island, six and one-half miles from Hartford. The channel follows the west bank of the river for about a mile above, and then crosses over the bar to the east side of the river. There is no channel to the eastward of Strong's Island, and just above it an extensive shoal reaches to the east bank. There is also another sand-flat above, bare at low water. These are all shown on the accompanying chart, No. 4, which embraces the whole river up to the Scantic.

It is proposed to form a channel over this bar by means of a wing-dam, extending out about 1,100 feet from the east bank, across the upper part of Strong's Island, as shown by the red line on chart No. 4. This will cut off the water now wasting to the eastward of the flat, and over it at ordinary stages of low water, and throw it into the channel. Between Strong's Island and the Scantic there are some stumps in the channel that will be required to be removed.

SCANTIC BAR. (Sheet No. 4.)

The bar at the mouth of the Scantic River, seven and one-half miles from Hartford, is, at present, the worst place on the river. Opposite the mouth of the Scantic and a little above there is an irregular bar, as shown by the survey, but ordinarily no trouble is experienced above the main bar just below. This commences at a point near Bissell's Ferry, and runs diagonally across the river to a point near the upper part of Strong's Island Flat, about half a mile below. It leaves a large and deep pocket on the east side of the river, just below the Scantic Ferry landing, which extends some distance down the river, and was probably once the principal channel.

The channel is now on the west side below Scantic bar, and is quite narrow for some distance, but by the means proposed for improving the bar the channel below will also be benefited.

By cutting off all the water from the present channel on the west side of the river the water might be forced to follow the east bank, at least as far as Strong's Island, but the uncertainty of changing the channel to this extent, as well as the increased expense, makes the improvement of the present western channel preferable.

It is proposed to improve this place in the river, by running out a wing-dam from the point of high ground just above the mouth of the Scantic, diagonally down stream about 1,400 feet, then turning more parallel to the current and continuing it about 600 feet further down. This will cut off and turn into the channel most of the water flowing over the flat into the deep pocket above mentioned near the Scantic shore.

The proposed construction will interfere with the present ferry-landings, but it is not seen how it can be avoided without greatly increased expense. By moving the ferry-landings a few hundred feet, which would come more nearly opposite the road leading to East Windsor Hill, the ferry can be operated below the proposed dam.

A portion of the structure might be left off for a time, to see the effect, and it might not be necessary to continue it so far down as to seriously interfere with the present road and landings.

THE CHARACTER OF THE WING-DAMS.

The river, through the whole length of the part embraced in the proposed improvement, is much wider than the average for the same distance below Hartford at ordinary stages of the water, although at extreme low water some few places become narrower. Wherever the bars formed the river is wide, and the proposed wing-dams are therefore quite long. In order not to interfere too much with the regimen of the river at higher stages of water, it seems desirable not to make these dams too high. A height of 2½ feet above low-water mark has been assumed for all of them, which reaches to the ordinary low-water level or a little above.

The section assumed is to have the top 3 feet in width and the slope on each side one horizontal to one vertical.

The best material available for the construction of these embankments is the broken stone and waste from the sandstone quarries on the river. This will form a permanent construction, not likely to be washed away during freshets, and will probably be found to be the cheapest mode of forming suitable wing-dams.

Stones of various sizes can be thrown in at random from scows, until the dam is built up to the dimensions described. It would not be water-tight, but sufficiently compact to offer the requisite obstruction to the flow of water.

There are large quarries at Portland, sixteen miles below Hartford, with great quantities of waste lying close to the bank of the river, and also a quarry at East Windsor, about nine miles above Hartford, with a railway to the river bank and good facilities for loading the stone into boats.

A suitable stone could probably be found at other points on the river, and quarried especially for this work, although, perhaps, it would not be so cheaply obtained.

Estimate of cost.

Wing-dam at Higley's Point, 600 cubic yards, at $3	$1,800 00
Wing-dam at Barber's Landing, 900 cubic yards, at $3	2,700 00
Wing-dam at Tunxis River, 700 cubic yards, at $3	2,100 00
Wing-dam at Strong's Island, 560 cubic yards, at $3	1,680 00
Wing-dam at Scantic River, 2,880 cubic yards, at $3	8,640 00
Removing stumps	80 00
Surveys already made, &c	3,000 00
Total	20,000 00

IMPROVEMENT OF ENFIELD FALLS.

My attention is called, in your communication of February 23, to a letter from Mr. Charles E. Buell, of Springfield, Massachusetts, to Mr. Minot, in regard to improving the Connecticut River, above Hartford, with a desire that I will consider it in making up my report.

Mr. Buell says:

"Every effort should be made to keep the appropriations from being expended except on the Enfield Falls, and to avoid the use of the present canal, or else every business interest above Windsor Locks must pay an unnecessary tribute to the canal company, while a trifling increase in outlay will give us a *free highway*, besides adding other valuable advantages, if a dam was constructed across the river at the foot of the falls."

There is no doubt that the canal at Enfield Falls is a great disadvantage to the navigation above, and, if possible should be avoided. From the foregoing statements and estimate it will, however, appear that the amount already appropriated will not more than cover the expense of the necessary improvement of the river up to the lower end of the canal. There seems to be no necessity for work on the Enfield Rapids until the river is in such a condition that they can be reached from below.

From my present knowledge of the river, I should say, however, that in the higher stages of the water the channel becomes navigable below the canal before it is passable at all over the rapids; that when the water rises much above the ordinary level boats can ascend or descend the river without passing through the canal, although the ascent is difficult.

The prevailing stage of the river during the months open to navigation is from one to two feet above low-water mark, at which stage the rapids are totally impassable, and the canal is used by such boats as can pass in the channel below to ascend the river.

Under these circumstances, there seems to be no doubt that the channel below the canal should be first improved, so as to make the communication with the river above good at all times.

With regard to further improvement, there is some question whether it is best to improve the present canal by widening and lengthening its locks, or to try to benefit the river channel in some other way.

I have not heretofore considered this question, as the appropriation already made would not more than meet the requirements below, and is totally inadequate to meet the expense of improvements on the canal or over the falls.

It is suggested by Mr. Buell, in the letter above mentioned, that a dam should be *built at the foot of the falls*. But he does not say how that is expected to benefit the navigation. He probably intends that a series of locks shall be made, in connection with it, to raise and lower the boats between the two levels, which would be from 25 to 28 feet.

This plan is practicable in an engineering point of view, but there are several objections to it as a means of improving the navigation of the river. In the first place is its cost. The dam at Holyoke, of about the same height and less width, has cost $600,000; the main dam having been built twenty years ago, when prices were much lower than now. The proposed dam, with its locks, would be, roughly, say, $250,000 more, or $850,000; an amount that it is not at all probable would ever be appropriated for the navigation that exists above Hartford.

The dam proposed would prevent all navigation except through the locks. No opening could be left, as in the present dam at the head of the falls, for boats to pass at high water.

The cost for attendance on the locks would probably amount to more than the tolls through the present canal, which is stated to be $1,200 for the year 1869. If a dam were possible on account of the expense, the proposed plan is probably not the best. A dam at the head of the falls, and a canal around the rapids, would probably prove cheaper and safer, and could be built more permanently, at less cost.

It appears to me, however, that all such questions involve too great outlay for the benefit derived. If the river between the points embraced by the canal can be improved so as to be passable for boats to a greater extent than at present, it would seem desirable to expend any future appropriations in that direction, especially as the dimensions of the locks in the present canal are far too small.

The canal is owned by the Connecticut River Company, chartered by the State of Connecticut for the purpose of improving the navigation of the river between Hartford and Springfield; and they have the right to make improvements anywhere on the river above Hartford. It does not appear, however, that they have ever done any other work than build the canal and dam, which latter, the charter provides, shall not interfere with boats ascending and descending the river. This it certainly does at the present time. The opening originally left in the dam has since been partially filled up by the company with blocks of stone.

The charter provides for commissioners, appointed by the governor and confirmed by the senate, who have power to stop the tolls on the canal whenever the company do not comply with the terms of the charter, and it is extremely doubtful if the present state of the canal and river would not warrant them in so doing.

A full investigation of all the facts connected with the river, and also with the rights of the Connecticut River Company, as well as a full and complete survey, will be necessary before deciding where future appropriations should be expended.

List of accompanying maps and charts.

1. Chart of Higley's Point Bar.
2. Chart of Barber's Landing Bar.
3. Chart of Tunxis River Bar.
4. Chart of Strong's Island and Scantic River Bars.
5. Map of the Connecticut River, from Hartford, Connecticut, to Hadley, Massachusetts, compiled from the latest county and town maps. The river from Hartford to Scantic is from actual survey.

Very respectfully, yours,

THEO. G. ELLIS,
Civil Engineer.

Major General G. K. WARREN,
Major United States Engineers.

T 11.

IMPROVEMENT OF NEW HAVEN HARBOR, CONNECTICUT.

The appropriation made for the fiscal year ending June 30, 1871, approved July 11, 1870, was $15,000. At the time of my annual report, dated September 30, 1870, I had begun work on Middle Rock by employing Mr. G. W. Townsend, as there stated, and already the results, as there reported, were unsatisfactory, and not in accordance with expectations formed from results previously reported. On the 9th of

September, 1870, Mr. Townsend began actual operations upon the rock, and the work was stopped by me on the 13th of October.

I made a full report of the condition of the work on the 20th of January, 1871, (printed H. Ex Doc. No. 95, third session Forty-first Congress,) to which I now refer and annex to this report. It is chiefly interesting in showing the uncertainty of the information there extant.

There was then a balance unexpended of $9,000. The act approved March 9, 1871, appropriated $40,000 in addition to what was on hand. There is nothing in either act specifying the manner in which the improvement shall be made; I therefore set out this year with the idea of making a thorough survey of New Haven Harbor, and this was begun on the 1st of April. The field-work was finished about June 23, 1871, and the maps are now in an advanced state, but not ready for transmission at this time, although sufficiently so to guide us in carrying on the improvement.

The United States Coast Survey published chart was made from a hydrographic survey in 1846. This does not give full enough information to determine the size and form of the rocky ledges at the entrance, and was not considered recent enough to be taken as a guide for the improvement of the upper portions of the channel-way. The survey, however, determined the depth up to Long Wharf to be now very nearly as represented on that chart, being about 7½ feet at mean low water, and the bottom composed of soft material. It was thought best to deepen this channel-way to 13 feet at mean low water, and at the same time renew operations upon the rocky ledges at the entrance. These rocks are probably projections on the continuous ridge of granite rock extending southwesterly from Morgan's Point, and are known as Quixe's Ledge, Big Boil, Middle Rock, (rocks marked B and C on Dutton's map,) Southwest Ledge, and Luddington's Rock. All should be removed except Quixe's Ledge, and perhaps Southwest Ledge.

Before the survey had been prosecuted far enough to determine the exact quantities, proposals were advertised for doing the dredging and removing the rocks.

The following is an abstract of the bids received:

Abstract of proposals for improvement of New Haven Harbor, Connecticut, received at the Engineer Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Name and address of bidder.	Excavating per cubic yard.	Removal of Middle Rock and others, as per specifications.	Commence.	Complete.	Remarks.
		Cubic yd.			
Morris & Cummings, New York City.	$0 17	....	On or about June 20, 1871	(*)	
L. E. Home, Boston, Massachusetts.	19.94	....	July 7, 1871	Nov. 1, 1871	Guarantee incomplete, in not having a certificate that the guarantors are responsible parties
Emory R. Seward, Albany, New York.	21	....	July 15, 1871	June 30, 1872	
S. F. Shortland & Brother, 106 Wall street, New York.	21.50	....	On or before June 30, 1871	As fast as possible.	
Sidney F. Shelbourne, 11 Gold street, New York.	22	....	As soon as practicable the present season.	June 30, 1872	Guarantee incomplete, in not having a certificate that the guarantors are responsible parties.

(*) If whole appropriation is expended for dredging, we could complete in about five months.

Abstract of proposals for improvement of New Haven Harbor, Connecticut, &c.—Continued.

Name and address of bidder.	Excavating per cubic yard.	Removal of Middle Rock and others, as per specifications.	Commence.	Complete.	Remarks.
H. N. & A. J. Beardsley, Bridgeport, Connecticut.	$22 50	....	June 20, 1871	As fast as possible.	
W. M. Tebo, 16 South street, New York.	27	....	July 1, 1871	....	
C. C. Campbell, 104 and 106 John street, New York.	27	....	July 1, 1871	Jan. 1, 1872	Bid informal, not in duplicate, and not accompanied by guarantee or copies of specifications.
E. G. Brown, Elizabethport, Union County, N. J.	29	....	June 15, 1871	Dec. 1, 1871	
Eugene Sullivan, 53 Long Wharf, Boston, Mass.	....	$25 00	July 1, 1871	June 30, 1872	
George W. Towsend, 22 State street, Boston, Massachusetts.	....	28 00	June 20, 1871	June 1, 1872	Guarantee incomplete, in not having a certificate that the guarantors are responsible parties; bid not accompanied by copies of specifications.
Sidney F. Shelbourne, 11 Gold Street, New York.	....	*41 50	As soon as practicable this season.	June 30, 1872	Guarantee incomplete, in not having a certificate that the guarantors are responsible parties.

(*) Measured in its bed, and to be paid for at that rate, for the number of cubic yards each month delivered on board scows or vessels until the work is done; then to be paid for according to the measurement in the bed before the work is commenced.

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

The dredging was awarded to Morris & Cummings, of New York, at 17 cents per cubic yard, (the material having all to be carried outside of the Southwest Ledge,) and the removal of the rocks to Mr. Eugene Sullivan, of Boston, at $25 a cubic yard, both offers being considered very advantageous to the Government.

Morris & Cummings commenced work with one of their powerful diggers on the 10th of July, and at the date of August 26, notwithstanding interruptions from passing vessels, had already excavated and removed 70,615 cubic yards. The cut made is from 600 to 700 feet long; is now about 150 feet wide and 13 feet deep up to Long Wharf. It is undetermined yet whether it is best to widen this channel-way to 300 feet, which is desired, or to extend it of the same width about as much farther, and give 13 feet draught up to the steamboat wharf.

The contractor, Mr. Sullivan, began work with a vessel well fitted out on Luddington Rock, and the 1st of August and during the month blasted and brought up 54 cubic yards of stone.

The contents of the different ledges of rock have been calculated from the surveys made this season, and the following table shows the amount to be removed to give a depth on them of 17 feet at mean low water.

These determinations are believed to be more reliable than those given in my report dated January 20, 1871:

	Cubic yards.
Middle Rock, (least depth of mean low water $10\frac{4}{10}$ feet)..........	818
Rock B, (least depth of mean low water 12.9 feet)...............	141
Rock C, (least depth of mean low water 11.4 feet)...............	624
Luddington Rock, (least depth of mean low water 9.8 feet).......	822
Total..	2,405

This, at the price of Sullivan's contract, is $60,125. At present rate of progress, $9,000 will be sufficient to pay all of Sullivan's work up to June 30, 1872, and remove 360 cubic yards from Luddington Rock, leaving 462 cubic yards, which, at $25, will cost $11,550. The appropriation of $40,000 will, besides making the survey, do all the dredging that seems especially required for the present.

If the complete removal of these rocks is determined on, as I think it should be, there should be double the force, and I recommend the appropriation of $20,000 for continuing this improvement.

New Haven is a port of entry and has a collector. The revenue collected during the fiscal year ending June 30, 1871, was $349,726 76.

T 12.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 20, 1871.

GENERAL: I have the honor to transmit the following report on "the improvement of New Haven Harbor, Connecticut."

This is the only one of the improvements of rivers and harbors under my charge that requires more information for the guidance of legislation in the present Congress than is to be found in my annual report.

In that report, in relation to New Haven Harbor, I promised a more detailed report. The experience of the present year (to be given further on) showed, at the time that was written, that we could no longer rely upon former estimates of cost and work to be done derived from earlier reports. The work required was not fully stated, and there was an erroneous idea given out of the cost of what *was* stated. When the last appropriation of $15,000 was made, it was believed that $10,000 was sufficient to complete the removal of Middle Rock down to a level 17 feet below mean low water. Our survey this year showed that the operations of 1867 had had but little effect in removing Middle Rock; that there were still but 10 feet water on it at mean low water; and that hence the estimate based upon that year's work of the cost of removing the rock was fallacious. My experience with the same parties at work upon the rock has shown that they are capable of much less rapid progress, and that instead of $10,000 being sufficient to remove the rock, it will require, at the same rate at which the work has hitherto been done, not less than $77,896 to remove Middle Rock alone. I commenced work at Middle Rock because that was a work begun and not finished, but the appropriation of $15,000 was for the improvement of New Haven Harbor, without regard to place, and it was as applicable elsewhere in the harbor as to Middle Rock.

Captain Dutton, United States Engineers, in his report, dated November 8, 1853, (printed Ann. Doc., 1853,) states that there are two other rocks near Middle Rock that should also be removed, and for which he made an estimate, as did also Colonel Houston in his annual report for 1868.

These before-mentioned rocks all lie on the entrance east of the Southwest Ledge, and in the channel principally used by coasters voyaging east of New Haven. On the west side of the southwest ledge is another entrance, principally used by vessels sailing between New Haven and New York, which are the larger part of those going to and from New Haven.

In this west channel is Luddington's Rock, which is a more dangerous obstruction, it is thought by many, than Middle Rock itself, and its two adjoining rocks. So that under the general provision to improve New Haven Harbor, it is a question if the removal of Luddington Rock should not take precedence of Middle Rock. Further, there is a very bad sand-bar midway in the approach from the entrance to the harbor and the wharves at New Haven, which many New Haven people think should receive attention before either of the rocky ledges before spoken of.

Seeing how inadequately the wants of the harbor had been stated, how imperfectly the obstacles to removing the obstructions had been comprehended, at the time the last reports were made to the Department, and feeling how little could be determined without further thorough surveys, I determined to suspend operations upon Middle Rock until the subject could as a whole be thoroughly examined and considered. I was further led to take this course from dissatisfaction with the efficiency of the means I was employing. The work to be done was of too great magnitude to be accomplished with such feeble preparations. It was necessary, in order to go to work in the right way, to expend as much money in preparation, at least, as all that we had available from the appropriation, and, of course, I would not feel justified in recommending this, except upon a full representation of the case to Congress, and have them appropriate enough money to make such preparation of value, by providing enough to work with afterward. If Congress is not willing to do this I hardly think it worth while to expend any more money in removing the rocks at the entrance to the harbor. At the time I ceased operations we had expended about $6,000 in actual work on the rock, and expenses of superintendence, and consequently there is now left $9,000 of the appropriation of $15,000.

With this I first propose to make a good survey of the harbor where obstructions exist, and determine all about them. I would have done it this season, but a crowd of other duties made it impracticable at the late season at which I discovered the necessity for it. After the survey I would recommend such use of the remainder of the appropriation as would be clearly beneficial to the harbor, if a suitable object for the amount of money available should be discovered.

I, however, at the present time know enough of this harbor to give some general observations which will place the matter in a different light from what it has heretofore been looked at. And first, a history of the attempts to remove Middle Rock shall be given.

About the year 1851 Mr. Benjamin Maillefert built an iron beacon in the Southwest Ledge, and he was led to think that Middle Rock presented a fair opportunity to employ his method of operating upon submerged rocky ledges, and, upon the recommendation of the collector of the port of New Haven, an appropriation was made for removing all of Middle Rock above the plane 17 feet below mean low water. A contract was entered into November 23, 1852, by Captain George Dutton, United States Engineers, with Mr. Maillefert, to remove the rock to a depth of 17 feet at mean low water for $6,000. After firing 36 charges, of 125 pounds each, upon the rock, Mr. Maillefert became satisfied from the results produced that he could not accomplish the work, and that it was probable that the estimate upon which he had based his contract had been made from an examination of another rock than Middle Rock, as there were two others near it, which he was not at first aware of. In August, 1853, Captain Dutton made another contract with Mr. Maillefert, which was to remove Middle Rock to a depth of 13½ feet below mean low water for $6,000. Mr. Maillefert then exploded 54 charges of powder upon Middle Rock, and found that the effect was considerably less than had been anticipated, and that the result could not be accomplished without a much greater expenditure of means than he had estimated. He therefore gave up the contract. His expenses, not counting his own time, were $1,978, but he was never allowed any recompense, though Captain Dutton recommended that he should be reimbursed for his expenditures.

Mr. Maillefert claims to have begun the work without any hope of profit, but regarded it as an experiment, in which he was willing to give all his time and efforts, but could not afford to lose the money he had expended. His case seems even now one that deserved liberal treatment in regard to this work, in view of the great difficulty which has so far attended all operations for removing submerged rocks. His method of operating was simply to place charges upon the rock and explod them at high tide, when the water pressure was the greatest. The mere concussion of the powder was expected to do the work of crushing the rock.

Middle Rock is a rounded mass of gneiss rock, of a firm structure, and well calculated to resist any kind of shock upon its surface. Mr. George W. Townsend, who has operated upon it, has repeated Mr. Maillefert's operation with the simple change of sending the powder down by a diver, while Mr. Maillefert placed it by lowering it from a boat, but the result was nearly the same, producing no valuable effect. Mr. Townsend has also employed the process of drilling holes, but his progress has even in this way been very slow and unsatisfactory at Middle Rock, while he has succeeded in removing Bulkhead Rock, Providence River, Rhode Island, to the required depth of 14 feet at mean low water by the same means that was so inefficient at Middle Rock, by exploding charges laid on the surface. Bulkhead Rock, however, was a rock with deep ridges, and was composed of a brittle conglomerate that fractured easily. Had Mr. Maillefert encountered such a rock, he would probably have succeeded in reducing it to at least a rounded surface. Captain Dutton expended $62 75 in making a survey of the rock and in examining those contiguous to it. In March, 1864, Captain Prime, United States Engineers, proposed to try the effect of gun-cotton upon the rock, but nothing was done.

Under Brevet Colonel Houston, United States Engineers, the work was resumed in 1867, and Mr. Townsend employed. The result, as reported to Colonel Houston, was very satisfactory, and he reported that all of the rock above the plane of 15 feet below mean low water had been removed by Mr. Townsend. Mr. Townsend must have been mistaken as to the reference of the plane of mean low water, and he was probably not aware that the top of the rock had been before determined to be about 10 feet below mean low water, instead of 15 feet, as he seems to have assumed. I make these inferences, because our survey in 1870, after our work was done, showed but 10 feet depth still on the rock at mean low water, and it is not possible that our operations could have diminished the depth. The difference which I have to make between my report and that of Colonel Houston has arisen, I am assured after the most patient investigation, from ignorance of Mr. Townsend about the true position of the mean low-water plane to which he thought he had referred his soundings. The difficulty of verifying submarine work, like this at Middle Rock, leads me to accept the statements of those who have gone down into the deep in person, especially when, as in this case, there is no *pecuniary* motive to falsify. I am satisfied Mr. Townsend *did not mean to misrepresent* the case. Colonel Houston's recommendations for the completion of the work were based upon the deductions derived from the sources reported by Mr. Townsend, and are, therefore, unreliable, and others must be made. Colonel Houston designed to remove the southwest ledge itself, and for all these works he thought $65,000 would be sufficient. (See Ann. Doc. for 1868.) Captain Dutton's estimate for the removing of Middle Rock, and the two adjacent to it, to a depth of 17 feet below mean low water, was as follows: (See Annual Report of November 8, 1853; President's Annual Message for 1853, pp. 291–295.)

Middle Rock, 1,330 cubic yards, (at about $18)..........	$36,000
Rock "B," 239 cubic yards, (at about $50)	12,000
Rock "C," 600 cubic yards, (at about $50)..................	30,000
	78,000

Captain Dutton gives no reasons for such different rates per cubic yard for Middle Rock and the others. According to our measurements in 1870, after stopping work, there were 728 cubic yards yet to be removed to get a depth of 17 feet on it at mean low water. As we know that a quantity so great as the difference between our measurement and Captain Dutton's had never been removed, we made calculations of the amount from his survey of 1853, and cannot make the amount to be removed at that time greater than 768 cubic yards. There has evidently been a mistake made somehow. Captain Dutton, it seems to me, reported the amount much too large; but there is a compensation in the cost of removing by his taking it at so much less than the others. I see no reason why there should not have been the same cost per yard estimated for Middle Rock as for the others. The amount of rock removed from Middle Rock, under my direction the past season, was 23 cubic yards. For this I paid Mr. Townsend $2,210; besides this, I paid $250 for powder-fuses, exploders, cartridge-cans, &c., not counting superintendence. This is an expenditure of $2,460, or at about the rate of $107 per cubic yard. The season was unusually favorable, and I do not think that, with the preparation which the little appropriation afforded, we could do better hereafter. Applying this to the quantity of rock yet to be removed, we have the following:

For Middle Rock, 728 cubic yards, at $107..................	$77,896
For Rock "B," 239 cubic yards, at $107....................	25,573
For Rock "C," 600 cubic yards, at $107	64,200
	167,669

I have no measurement of Luddington's Rock. With ample preparation, we might be able to remove these rocks at a rate of $50 per cubic yard, which would make the above estimate become $78,350. I would therefore recommend that an appropriation be made of that amount, and if this cannot be afforded, that the work be for the present abandoned.

The history of the removal of the Middle Rock, which I have given in the preceding parts of this report, shows that—

Mr. Maillefert expended upon it............................	$1,975
Captain Dutton and Colonel Houston, (for the United States)...	6,000
Myself, (for the United States)......	6,000
Total..	13,975

Comparing our survey with Captain Dutton's, we have all together removed 40 cubic yards of the rock, costing on the average $349 37½ per cubic yard. If we go on in this way, there is no way of judging what amount of money might be expended in a long time before the work would be accomplished. I do not care to estimate on such a basis. The only way to do the work of improving the entrance to New Haven Harbor is to take the full measurement of what is to be accomplished, suppose that sufficient means will be granted, and make such estimates as the magnitude of the work to be done requires, and the preparation for the work made proportionately.

The business of New Haven requires that there should be a channel dredged 200 feet wide and to a depth of 14 feet at mean low water, up to the wharves. At present there is not more than 7 feet at mean low water. The mean rise of tides is 5.8 feet. To make the required channel would require the removal of 259,260 cubic yards of ordinary dredging material, at a cost of 25 cents per cubic yard, requiring $64,815.

This dredging is in many respects more important to New Haven than the removal of the rocks at the entrance to the harbor.

New Haven harbor is a fine harbor of refuge for coasters. Immense fleets anchor here in unfavorable winds. It deserves all the consideration due to an important harbor of refuge against disasters and loss of life that attaches to such places.

New Haven is in the collection district of New Haven; it is its own port of entry. The amount of revenue collected during the last fiscal year was $234,773 38.

The harbor is in the third light-house district, and there is a light-house on the east side of the entrance. There is a fort constructed for its defense. In view of the importance of the harbor, I would recommend that Congress regard the complete improvement as an object worthy of the consideration of the Government, and that a liberal appropriation toward the end be made, so that preparation can be made adequate to its full attainment.

With this view, it is therefore recommended that an appropriation be made for improving New Haven Harbor of $75,000.

Accompanying this report is a sketch showing the general position of the rock at the entrance to New Haven Harbor.

A tracing of the survey of Middle Rock, made by Captain Dutton in 1853, in black.

A tracing of the survey made by Benjamin Maillefert in 1853, in blue.

A tracing of the survey made by ourselves in 1870, in red.

The tracings of Middle Rock are so arranged that they can be readily compared by superposition.

I send also the report of Mr. George H. Mann, civil engineer, who superintended the operations at Middle Rock the past season.

Yours, respectfully,

G. K. WARREN,
Major of Engineers, Bvt. Maj. Gen., U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

ENGINEER OFFICE UNITED STATES ARMY,
Newport, Rhode Island, January 20, 1871.

GENERAL: I have the honor to submit the report of operations at Middle Rock, New Haven Harbor, Connecticut, together with the information in regard to other obstructions in the harbor, and the deductions drawn from a careful survey of the rock. Operations were commenced at the rock on the 6th of September, and were continued until the 13th of October, when, in accordance with your orders, the work was stopped. During the time the weather was unusually favorable, but nine days being lost on account of bad weather, out of a total of thirty-two and a half, and most of this was owing to comparatively light winds, which, on account of the exposed position of the rock, prevented operations, the progress of the work was not at all satisfactory, but 50 tons being removed in twenty-three and a half working days, or less than two tons a day. I consider the failure of the operation due to the following causes, which could in future attempts be obviated:

1st. Insufficient numbers and bad form of drills.

2d. Improper placing of the drill-holes, causing them, when blasted out, to form simply a crater, owing to the line of least resistance being too great for the explosive energy of the powder.

3d. Defective hoisting-apparatus, much time being lost in chaining rock, which would have been saved by improved apparatus.

4th. No means of sharpening drills, which, owing to the exceeding hard character of the rock, became very rapidly dull, especially when the drilling-machine is run at a velocity sufficient to secure rapid progress.

5th. Too much reliance on face and surface blasts. Experience here and elsewhere has demonstrated the waste of time and powder in attempting to blast granitic rock by this method; the resistance of the water is inadequate to cause anything like enough concussion to shatter the rock; and in order to remove rocks of this character, drilling must be resorted to.

6th. Non-adaptability of the drilling-machine to the character of the rock. This will be evident when the record of the progress is stated. The best duty done was at the rate of 5 inches an hour, the hole being 4 inches in diameter. The average duty is not over 4 inches per hour. The average number of strokes per minute was about fifty, when at least one hundred is necessary for rapid drilling. The machine is liable to derangement, and though well enough adapted for soft rock, does not strike a heavy enough blow to produce much effect on a rock as hard as Middle Rock, the stroke being but 8 inches, and the weight striking only 125 pounds. Middle Rock is marked by a red spar-buoy placed by the Light-House Board, and is about one and one-fourth miles from the New Haven light, in a south-by-southwest direction. It is about 75 feet by 90 feet, running in a northeast and southwest direction. The composition is that of a coarse-grained, yellow, granitic rock, the quartz being largely in excess, thus rendering it very difficult to drill. After the conclusion of the blasting operation, a survey was made by anchoring two vessels in parallel lines 60 feet apart. The sides of the vessels were marked off in distances of five feet. A nine-thread line, with strips of red bunting inserted into a distance of 10 feet, was employed to sound along, the soundings being therefore taken at the corners of rectangles 5 feet by 10 feet. The soundings were reduced to mean low water, and give, as the least depth on the rock, 10 feet.

The rock is abrupt on the northwest side, running up to a peak, and sloping quite gradually on the southeast side. The water about the rock has a depth of 22 feet at mean low water. I am unable to see that Mr. Townsend accomplished anything of importance in 1867, the survey failing to show not only that the depth of water over the rock had been increased, but also soundings taken about the edges of the rock give no evidence of the large quantities of rock asserted to have been tumbled into deep water by Mr. Townsend.

In case it should hereafter be determined to remove the rock, I would recommend that a vessel and working-party be hired directly by the Engineer Department, and that either nitro-glycerine or gun-cotton be used in connection with powder. Nitro-glycerine could be readily made on shore and taken out when required. Also, that some investigations be made in regard to the working of drilling-machines, run by compressed air, for submarine working. Whatever form of drilling-machine is employed, a row of holes should be drilled along one face of the rock and exploded simultaneously. For hoisting small fragments, I would suggest a tub of boiler-iron, with a grated bottom, opening about a hinge. Middle Rock is not as formidable an obstruction to navigation as Luddington's Rock, about three-fourths of a mile to the southwest, and directly in the channel of the west entrance to the harbor. From the statements of the harbor pilots, I would conclude that the rock has over it about 10¼ feet of water at low water. The form is that of a frustum of a cone, about 15 feet across at the top, and running down abruptly for a short distance, and then sloping off gradually into water 25 feet deep at low water. There is, I believe, no buoy upon it at present, although one is represented on the United States Coast Survey chart. In the inner harbor Middle Bar obstructs the channel to a great extent, and should be dredged through. Until a thorough survey is made of the harbor, it is impossible to state with any degree of certainty the points at which dredging would be most advantageously done, as many changes have taken place since the last survey was made.

I am, general, yours, very respectfully,

GEORGE H. MANN,
Civil Engineer.

General G. K. WARREN,
Corps of Engineers, U. S. A.

T 13.

SURVEY AND IMPROVEMENT OF THE HOUSATONIC RIVER, CONNECTICUT.

This survey was finished and reported January 23, 1871, and printed in H. Ex. Doc. No. 95, third session Forty-first Congress. The amount estimated therein for improving the river, exclusive of the bar at the mouth, was $24,886. The amount appropriated by the act approved March 3, 1871, was $15,000.

Advertisements for proposals to do the work were duly made, and the following is an abstract of those received:

Abstract of proposals for improving the Housatonic River, Connecticut, received at the Engineer Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Name and address of bidder.	Excavating at points named in specifications.				Embankment.		Removal of Drew's Rock.	Commence.	Complete.	Remarks.
	Two-Mile Isl. and Bar.	Crofut's Bar.	Drew's Bar.	Mill Bar.	Sow and Pigs Rocks.	Drew's Rock.				
	Per c. yd.	*Per c. yd.*	*Per c. yd.*	*Per c. yd.*	*Per c. yd.*	*Per c. yd.*	*Per c. yd.*			
R. W. Myers, Stamford, Conn.	$0 18 *	$0 18	$0 18	$0 18	$1 90	$1 90	$21 90	July 1, 1871	Oct. 1, 1871	Bid informal; the guarantee is imperfectly filled out, so that the guarantors do not insure the making of a contract if the award is made to Mr. Myers.
H. N. and A. J. Beardsley, Bridgeport, Conn.	19.50	19.50	19.50	19.50	2 50	2 50	....	July 20, 1871	(*)	
R. M. Jones, New York	19.73	19.73	19.73	19.73	....	....	....	July 1, 1871		
S. F. Shortland & Bro., 106 Wall street, New York.	19.75	19.75	19.75	19.75	....	....	....	June 30, 1871	(†)	Bid informal, in not having a certificate that the guarantors are responsible parties.
Francis H. Smith, 121 and 123 Front street, New York.	21.40	21.40	21.40	21.40	5 36	5 36	....	July —, 1871	(‡)	
Emory R. Seward, Albany, N. Y.	24	24	24	24	....	....	....	Aug. 1, 1871	June 1, 1872	
C. C. Campbell, 104 and 106 John street, New York.	26	26	26	26	4 86	4 86	....	July 1, 1871	Jan. 1, 1872	Bid informal, not in duplicate; no guarantee, and not accompanied by copies of specifications.
Morris F. Brainard, Albany, N. Y.	32	33	20 §	22	....	....	....	July 1, 1871	Nov. 1, 1871	
Norris G. Dodge, Little Falls, N. Y.	35	35	32	....	2 00	2 00	10 00	July 20, 1871	June 30, 1872	
E. G. Brown, Elizabethport, Union County, N. J.	35	35	35	35	....	....	....	June 15, 1871	Jan. 1, 1872	
W. M. Tebo, 16 South street, New York.	36	36	36	36	....	....	....	July 1, 1871		
Albert Blaisdell, post-office box 67, Charlestown, Mass.	....	....	....	....	2 75	2 75	15 00	July 5, 1871	Oct. 1, 1871	
J. H. McCormick, 99 Maiden Lane, New York.	....	....	....	....	4 89	4 74	....	July 1, 1871	(‖)	
Eugene Sullivan, 53 Long Wharf, Boston, Mass.	....	....	....	....	....	....	¶ 22 00	July 1, 1871	June 1, 1872	
George W. Townsend, 22 State street, Boston, Mass.	....	....	....	....	....	....	24 00	June 20, 1871	Dec. 1, 1871	Bid informal; no certificate to guarantee.

* With despatch.
† As fast as possible.
‡ As soon as practicable.
§ If dredged on the west side; 30 cents on east side.
‖ In a reasonable time.
¶ To be measured by weight.

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

The contract was awarded to P. W. Myers, of Stamford, Connecticut, for all but the removal of Drew's Rock, which it was thought best not to attempt with the present appropriation.

Mr. Myers commenced work in dredging on Drew's Bar in July, and has continued at work since. The wing-dam at Sow and Pigs Reef will be commenced in September.

I recommend an additional appropriation of $15,000 to continue the improvement and make a thorough survey at the mouth.

The Housatonic River is the boundary between New Haven and the Fairfield collection district.

The revenue collected during the fiscal year ending June 30, 1871, was, at New Haven $349,726 76, and at Bridgeport, in the other district, $7,193 96. Bridgeport is the nearest port of entry.

I have annexed hereto my report made last January upon the survey of the river, to which I have added the tide observation at Stratford and Derby. Mr. Edwards's report does not describe the bench-marks to which this mean level has been referred, but it is my design to have a permanent mark made, if it has not already been done, so that this level can hereafter be readily found.

Record of tide observations at Stratford and Derby, on the Housatonic River, Connecticut, made in 1870.

STRATFORD.*

Date.	Low water.	High water.	Rise.	Fall.
			Feet.	*Feet.*
October 19, 1870	1.00 p. m.	....	....	3.20
October 19, 1870	....	7.06 p. m.	4.85	....
October 20, 1870	1.25 a. m.	8.00 a. m.	5.60	4.30
October 20, 1870	2.40 p. m.	8.35 p. m.	6.60	6.00
October 21, 1870	3.30 a. m.	8.55 a. m.	3.90	5.50
October 21, 1870	3.30 p. m.	9.15 p. m.	5.40	4.40
October 22, 1870	4.10 a. m.	9.50 a. m.	5.10	5.30
October 22, 1870	4.35 p. m.	10.00 p. m.	5.30	5.35
October 23, 1870	5.15 a. m.	10.30 a. m.	5.30	5.30
October 23, 1870	5.30 p. m.	10.40 p. m.	5.70	5.50
October 24, 1870	6.00 a. m.	11.30 a. m.	5.70	5.70
October 24, 1870	6.40 p. m.	11.45 p. m.	5.40	5.50
October 25, 1870	7.00 a. m.	12.10 p. m.	5.70	5.50
October 25, 1870	7.30 p. m.	....	....	5.80
October 26, 1870	....	12.35 a. m.	4.90	....
October 26, 1870	7.35 a. m.	12.35 p. m.	6.40	4.90
October 26, 1870	8.05 p. m.	....	....	6.20
October 27, 1870	8.10 a. m.	1.00 a. m.	6.40	5.90
October 27, 1870	9.00 p. m.	1.15 p. m.	6.20	6.30
October 28, 1870	9.25 a. m.	1.45 a. m.	5.40	5.90
October 28, 1870	10.00 p. m.	2.15 p. m.	5.00	5.50
October 29, 1870	10.15 a. m.	2.45 a. m.	4.40	4.00
October 29, 1870	10.45 p. m.	3.15 p. m.	4.80	5.20
October 30, 1870	11.00 a. m.	4.05 a. m.	4.70	3.90
October 30, 1870	11.15 p. m.	4.30 p. m.	5.20	5.90
October 31, 1870	1.00 p. m.	5.30 a. m.	5.40	5.40
October 31, 1870	....	6.00 p. m.	3.70	....
November 1, 1870	1.10 a. m.	6.43 a. m.	4.00	5.60
November 1, 1870	1.20 p. m.	7.15 p. m.	4.50	3.60
November 2, 1870	2.00 a. m.	7.30 a. m.	4.40	4.30
November 2, 1870	2.20 p. m.	8.15 p. m.	5.00	4.10
November 3, 1870	3.00 a. m.	8.30 a. m.	4.80	4.50
November 3, 1870	3.30 p. m.	9.00 p. m.	3.60	4.60
November 4, 1870	4.30 a. m.	9.35 a. m.	4.10	4.90
November 4, 1870	4.20 p. m.	10.00 p. m.	4.20	3.90
November 5, 1870	5.00 a. m.	10.15 a. m.	4.30	3.90
November 5, 1870	5.15 p. m.	10.30 p. m.	4.50	4.40
November 6, 1870	5.30 a. m.	10.40 a. m.	6.20	4.00
November 6, 1870	6.00 p. m.	11.10 p. m.	4.40	6.30
November 7, 1870	6.00 a. m.	11.20 a. m.	4.80	4.20
November 7, 1870	6.30 p. m.	12.00 p. m.	4.40	5.50
November 8, 1870	6.30 a. m.	12.00 m.	5.40	3.70

* Mean rise and fall at Stratford 4.98 feet.

Record of tide observations, &c.—Continued.

Date.	Low water.	High water.	Rise.	Fall.
			Feet.	*Feet.*
November 8, 1870	7.00 p. m.			5.50
November 9, 1870	7.50 a. m.	12.15 a. m.	3.90	3.70
November 9, 1870	7.15 p. m.	12.30 p. m.	5.60	5.60
November 10, 1870	7.45 a. m.			4.30
November 10, 1870	8.00 p. m.	12.45 p. m.	4.10	4.50
November 11, 1870	8.15 a. m.		5.10	
November 11, 1870	8.35 p. m.	1.20 p. m.	4.50	4.30
November 12, 1870	8.45 a. m.			
November 12, 1870	9.15 p. m.	2.10 p. m.	4.90	4.60
November 13, 1870	9.25 a. m.			
November 13, 1870	10.00 p. m.	2.30 p. m.	4.00	4.55
November 14, 1870	10.00 a. m.			
November 14, 1870	10.20 p. m.	3.30 p. m.	4.80	4.80
November 15, 1870	10.40 a. m.	4.15 a. m.	3.70	3.50
November 15, 1870		4.40 p. m.		
November 16, 1870	12.00 m.	5.15 p. m.	4.00	4.10
November 17, 1870	1.15 p. m.	6.40 p. m.	4.20	4.20

DERBY.*

Date.	Low water.	High water.	Rise.	Fall.
			Feet.	*Feet.*
October 19, 1870	2.40 p. m.	8.10 p. m.	4.80	3.20
October 19, 1870	3.30 a. m.			
October 20, 1870	3.30 a. m.	9.10 a. m.	5.90	5.00
October 20, 1870	4.20 p. m.	9.10 p. m.	5.20	4.60
October 21, 1870	4.20 a. m.	9.50 a. m.	4.00	5.70
October 21, 1870	5.20 p. m.	10.00 p. m.	5.25	4.30
October 22, 1870	5.50 a. m.	10.50 a. m.	5.00	5.25
October 22, 1870	6.50 p. m.	11.00 p. m.	5.10	4.90
October 23, 1870	7.10 a. m.	12.10 p. m.	4.30	5.30
October 23, 1870	7.20 p. m.	11.50 p. m.	5.10	4.30
October 24, 1870	7.50 a. m.	12.10 p. m.	5.75	5.10
October 24, 1870	8.30 p. m.	12.40 a. m.	5.00	5.65
October 25, 1870	8.00 a. m.	1.00 p. m.	5.65	5.05
October 25, 1870	9.20 p. m.	1.20 a. m.	4.75	5.75
October 26, 1870	9.20 a. m.	1.40 p. m.	5.80	4.80
October 26, 1870	10.00 p. m.	2.30 a. m.	5.50	5.80
October 27, 1870	9.50 a. m.	2.30 p. m.	6.50	5.30
October 27, 1870	10.50 p. m.	3.10 a. m.	4.60	6.20
October 28, 1870	11.10 a. m.	3.40 p. m.	4.90	5.10
October 28, 1870	12.10 p. m.	3.30 a. m.	5.05	5.15
October 29, 1870	12.00 m.	4.30 p. m.	4.50	4.50
October 29, 1870	12.50 p. m.	5.30 a. m.	4.45	4.85
October 30, 1870	12.30 p. m.	5.20 p. m.	5.35	4.05
October 30, 1870	1.30 a. m.	6.00 a. m.	6.10	5.10
October 31, 1870	2.30 p. m.	7.10 p. m.	2.90	5.80
October 31, 1870	3.00 a. m.	7.20 a. m.	3.40	3.70
November 1, 1870	3.00 p. m.	8.00 p. m.	4.20	3.15
November 1, 1870	3.50 a. m.	8.30 a. m.	4.20	4.25
November 2, 1870	3.50 p. m.	9.00 p. m.	4.75	3.75
November 2, 1870	4.30 a. m.	9.30 a. m.	4.85	5.10
November 3, 1870	5.10 p. m.	9.40 p. m.	4.90	5.00
November 3, 1870	5.50 a. m.	10.30 a. m.	4.75	4.30
November 4, 1870	6.20 p. m.	10.50 p. m.	3.35	4.40
November 4, 1870	6.10 a. m.	11.00 a. m.	3.75	4.30
November 5, 1870	7.10 p. m.	11.10 p. m.	4.05	4.50
November 5, 1870	6.50 a. m.	11.30 a. m.	4.10	4.00
November 6, 1870	7.50 p. m.	12.20 a. m.	5.20	4.40
November 6, 1870	7.40 a. m.	12.00 m.	4.05	4.30
November 7, 1870	8.10 p. m.	11.50 a. m.	5.10	4.10

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* Mean rise and fall at Derby is 4.95 feet,

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ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 23, 1871.

GENERAL: I have the honor to submit the following report, with maps, of the "survey of the Housatonic River below Derby," authorized by section 2 of the act making appropriations for rivers and harbors, approved July 11, 1870.

The Housatonic River from Derby to the outer bar is thirteen miles long.

A special report on the general character and capacities for commerce of this river was made to you by Major D. C. Houston, brevet colonel, January 8, 1870, printed in H. Ex. Doc. No. 62, second session Forty-first Congress. In that it is estimated that a thorough survey of the river below Derby would cost $5,000. The amount allowed to me for all the surveys I had to make (though a liberal one, considering the amount of the appropriation from which it was taken, and the great number of surveys expected to be made with it) was at first but $6,000, and, in making a due apportionment to the different surveys intrusted to me, I found that $2,000 was all that I could spare to the survey of the Housatonic River. A preliminary examination by General Theodore G. Ellis, civil engineer, designated the points to which the survey should be confined, and it was placed in charge of Mr. W. S. Edwards, civil engineer, formerly an assistant on the United States Coast Survey. His report, dated January 1, 1871, and maps, in three sheets, on a scale of 24 inches to the mile, are transmitted herewith, and made a part of my report. He made detailed surveys at the Sow and Pigs-Reef, Two-Mile Island, Crofut's Bar, Drew's Rock and Bar, and Mill Bar and Rock. His report is clear and brief, and I refer to it for information with regard to these localities. His estimate for improving the river so as to secure a draught of 7 feet at mean low water is $24,486, which I approve.

The above surveys and plans of improvement were directed with a view to meeting the wants of the case as presented in Colonel Houston's report on January 8, 1870, already referred to, and quoted in your report, January 14, 1870, to wit:

> The river is now considered navigable for vessels drawing 7 feet, *i. e.*, by taking advantage of the tides; but, owing to the variation between the times of high water between Derby and the mouth, (by our survey in 1870, one hour,) delays are experienced in crossing the upper bars. It is considered that if the depth of water on the upper bars can be increased, a great improvement would be made, even if the lower bar should remain untouched. It may be found, however, after a detailed examination that the latter admits of improvement.

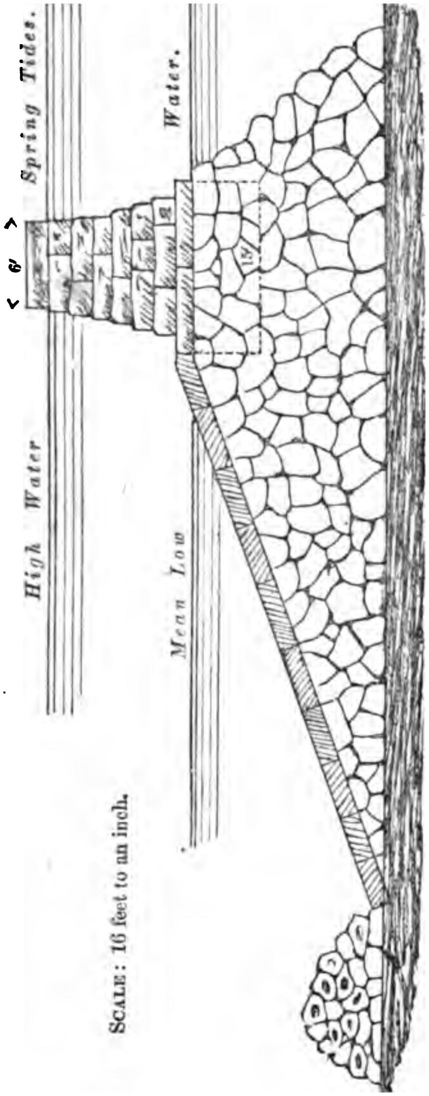
Mr. Edwards made an estimate that it would require about $700 to make a proper survey of the mouth of the river, and on this representation to you the additional allowance was made to me. It came however so late that it was not practicable to present the result of such survey to Congress at this session, and the season had become very unfavorable to such work. I, however, had some soundings and measurements made by Mr. Edwards at an expense of $115, which have just reached me in time to be available for this report.

The result of this examination is shown in red on the accompanying copy of the United States Coast Survey of the Housatonic below Derby made in 1837. This map also has the location of the three sheets of detailed survey made by Mr. Edwards the past year.

It will be seen by examining this map that considerable changes have taken place at the mouth since 1837. The sand-spit on the east side of the harbor has lengthened like all others that I have examined. A new outlet has been formed near this east side sand-spit, and a portion of the land formerly dry at low water has been washed away near the main entrance, as has also a small low-water island formerly in the main channel.

But the depth of the water on the bar is substantially the same, viz, 3 to 4 feet at low water, according to the kind of tide, thus showing that this depth is the result of certain forces not materially modified by any natural changes in the form of the outlet.

I am, therefore, firmly of the opinion that, unless we change the operations of these natural forces by artificial barriers to the action of the waves, there is but little hope of any improvement by dredging, and I regard it as an essential preliminary to dredging at the mouth to build a breakwater there, however expensive this latter may be.



My plan is to close up the new outlet and build a sea-wall from the sand-spit on the east side out to the line of lowest water, a distance of 2,100 feet. This wall to be 8 feet wide on top, 14 feet wide at mean low-water level, and to rise 12 feet above mean low water. It is to be built of large blocks of rubble-stone, except the top course, which must be of single stone, 2 feet thick, 8 feet long, clamped together, and the bottom course, which must be made of stone so long that two of them shall reach entirely across the bottom.

To fill the new outlet with riprap and brush, 540 cubic yards, at $5	$2,700
To build the wall, 12,800 cubic yards, at $10...	128,000
	130,700

From extreme low-water line out to the 6-foot curve, a distance of 2,100 feet, I would build a breakwater on the following plan, being the same I have recommended for Bridgeport and Port Jefferson Harbors.

Section of breakwater. Spring tides rise 9 feet above mean low water. The top of the wall to rise 2 feet above high water of spring tides.

Wall to be 6 feet wide on top; batter 4 upon 1, down to 1½ feet above low water; to be composed of granite blocks of from 2 to 4 cubic yards each, of a thickness from 18 inches to 2 feet; to be doweled throughout with gun-metal dowels, and top course securely clamped with wrought iron of suitable size, (cost, say, $25 per yard.)

This wall to rest on a bed formed by throwing in large irregular blocks of stone of not less than 1¼ tons weight, having a slope seaward of one upon three, and shoreward one upon one, and to be 15 feet wide on top at level of mean low water. This foundation to be brought to even surface by small angular stones, and paved on the sea slope with large granite blocks 1½ feet thick, and not less than 2 tons weight, clamped with wrought iron. The foot of the paved to be protected by large riprap stone, same as for the body of the breakwater; to contain about 4 cubic yards per lineal yard of breakwater. All the riprap to cost, say, $6 per yard, the pavement, $25 per yard.

The above wall is proportioned so as to be about the same cost as a rough breakwater would be made of the same height, namely, 11 feet. As the height increases, there is a great saving in combining them as I have.

This particular form is adapted as the basis of calculation. It may be modified in practice as may be necessary. The body of the work may not need paving.

From the experience with the sea-wall at Southport, the thickness of wall adopted will be sufficient to stand the waves of Long Island Sound. The Southport sea-wall is 9 feet above ordinary low water, and it is thought that 2 feet additional height should be given it. That is the reason a height of 11 feet is taken above mean low water for this design. The waves in heavy storms and high tides will break over such wall, but not enough to cause any swell, and if the wall be well built, it will probably stand the shock. However this wall may answer, it is probable that a higher structure of stone should not be adopted.

To build the body of the breakwater, 2,800 cubic yards of large riprap stone, at $6	$16,800
To pave the outer slope, if necessary, 630 cubic yards, at $25	15,750
For 1,400 cubic yards riprap at base of outside slope, (if paved,) at $6	8,400
To build top wall, 7,875 cubic yards, at $25	196,825
Total for breakwater	237,775

For dredging to secure depth of 7-foot over the outer bar of a width of 200 feet, 40,000 cubic yards, at 30 cents	$12,000

Making a total for improving the mouth of the river as follows:

For sea-wall from high-water line to low-water line, filling up uneven places, &c	$130,700
For building breakwater out to the 6-foot curve	237,775
For dredging on the outer bar	12,000
Total	380,475

It is proper to make a few additional remarks in regard to the improvement of this river.

The survey shows that the tide-wave moves up the river at the rate of three miles an hour. The mean velocity of the current is not determined, but supposing it is at least one mile an hour, as its duration being about four and one-half hours, a vessel would drift alone four and one-half miles on one tide, but during the time the crest of the high-water wave was ascending the river she would drift but one mile, leaving twelve miles to overcome by sails or steam.

This would require a rate of speed of the vessel through the water of twelve miles an hour. A steamboat crossing the outer bar at full tide could easily reach Derby in one hour, and would carry the flood with her. No sailing vessel, however, could do so, and the tide would be falling before she reached Derby. Therefore dredging on the upper bars alone would be a great assistance, as stated by Colonel Houston.

A vessel departing from Derby, even a steamer, at high tide, would occupy an hour in reaching the mouth, and would reach there after the tide had been falling, probably, for two hours. What the depth on the bar at that stage is will require a further survey to determine, but it is evident that in order to prevent delays to outward-bound vessels, amounting in time to at least one tide, the bar at the mouth should be improved so as to give the same depth at mean low water as other parts of the river. There is some advantage in helping the vessels inward bound, more than when outward bound, because, in the first case, there are many of them who come heavily laden with coal and lumber, which depart light. But for the wants of steamboats carrying passengers, it is essential to have the bar at the mouth improved the same as the others. Travelers will not take conveyance, when they can avoid it, if there is a liability to be delayed at every tide.

There is a railroad and highway bridge across the river about one and one-half miles above Stratford, and seven miles above the mouth, with draws. The railroad bridge is being rebuilt, and it is understood the highway bridge is to be removed.

Mr. Edwards does not mention these bridges in his report, although his map shows that he made current observations at the draws.

The town of Derby is located at the junction of the Housatonic and Naugatuck Rivers, at the head of navigation, and about thirteen miles from its mouth. The Naugatuck Railroad runs through it and connects it with the New York and New Haven Railroad. There is a steamboat plying between Derby and New York when the river is free from ice. There are many flourishing manufactories along the Naugatuck River, the supplying of whose raw material would be much cheapened by improving the Housatonic River. There has been erected a large and expensive dam across the river at Derby, which promises to afford a water-power capable of rivaling, I am informed, the mills of Lowell. In view of this, the importance of good and reliable water transportation to Derby is of much importance.

The Housatonic is in the collection district of New Haven, Connecticut. The nearest port of entry is Bridgeport. The revenue collected at Bridgeport in the fiscal year ending June 30, 1870, was $12,164, and at New Haven, $234,773 58. It is in the third light-house district, and there is a light-house at Stratford Point, near the mouth.

With the means at present on hand, I propose to have a good survey made of the mouth of the river in the spring. It will be useful in future considerations of the subject, if nothing is done there toward improving it. I would, however, recommend the following appropriation for the next fiscal year:

For beginning sea-wall at the mouth of the river	$50,114
For dredging	24,886
	75,000

Yours, respectfully,

G. K. WARREN,
Major of Engineers, Brevet Major General.

Brevet Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army.

BRIDGEPORT, CONNECTICUT,
January 1, 1871.

GENERAL: In conformity with your instructions, dated September 30, ordering a survey of the Housatonic River between Derby and the mouth of the river, I respectfully submit the following report of survey and estimated cost of improvements, with accompanying maps, consisting of three sheets, showing detailed surveys at five different points on the river.

As the necessities of the case did not demand, or the appropriation warrant, a close survey of the whole river, the work was limited to those places which offered the greatest obstacles to navigation, which points were chosen after personal examination and consultation with those habitually navigating the river.

Tides.—For the determination of mean low water, two tide-gauges were established. One at Derby steamboat-wharf, the other at Hubbell's wharf, at Stratford. As each bar was sounded, tidal observations were made at that bar, during the time of sounding and at high and low water preceding and following the soundings. The tides were observed for thirty consecutive days, day and night.

The mean rise and fall, as determined from these observations, was, at Derby, 4.76 feet; at Stratford, 4.98. The high water is one hour later at Derby than at Stratford. Mean duration of the flood-tide, 4 hours 27 minutes; of the ebb, 7 hours 15 minutes.

The method of sounding was as follows: Base-lines were measured along the shore as near as possible at right angles to the stream. At intervals of fifty feet on these base-lines, flags were set up, and right angles turned off from the base, and other flags set up at distances of 80 to 150 feet as range-flags; on these ranges soundings were taken. These base-lines were afterward connected by a system of triangulations, with points already determined by the Coast Survey.

Commencing at Derby, the first serious obstacle to navigation is a reef of rocks in mid-channel, known as the Sow and Pigs Reef. This reef, which is a spur or ledge, is just covered at high water. There are three points of it, on the highest of which there is an iron rod with key, 6 feet above the level of high water. It is 90 feet from the east bank, with deep water between it and the bank, but on account of the curve of the shore, not wide enough for a channel-way. A shoal runs out from the west side, narrowing the channel-way down to 46 feet. The object of improvement here must be to widen the channel-way on the west side of the rock. Closing the passage between the rock and the east bank would soon clear the channel on the west side of the rock by the natural scour of the water. I estimate the expense of closing this passage to be $4,000.

The next point, a mile and a half below the steamboat wharf, is at the head of what is known as Two-Mile Island, from which the bar takes its name. It is a sand-bar with 4 feet on it at low water for a distance of 495 feet, and a depth of 5 feet for a distance of 2,000 feet.

The improvements needed here are a deepening of the channel to 7 feet, with a width of 150 feet. To accomplish this, 16,000 cubic yards of sand will have to be dredged out, at an estimated cost of $4,000.

Crofut's Bar.—This bar is just above Wooster's Island, and has 6 feet on it at low water for a distance of 600 feet. Improvements needed here are a deepening of the water to 7 feet. The east side of the island offers a convenient place for deposit of materials dredged. This will require the removal of 6,000 cubic yards of sand, at an estimated cost of $1,500.

Drew's Rock and Bar.—These rocks consist of two spurs of ledge, cropping out in mid-channel, 86 feet from the west bank of the river. The outer and larger rock is covered at high water, and has an iron spindle and key the same as the Sow Rock; the inner rock has 2 feet water over it at mean low water, and is 27 feet distant from the outer rock. It will be necessary here to remove these rocks by blasting, and make 7 feet water over them at low water. To do which will require the blasting and removal of 357 cubic yards of rock, at an estimated expense of $2,000.

The bar extends 1,320 feet above the rock, and has an average depth of 3 feet at low water. It is composed of a compact sand and some gravel. To deepen this bar to 7 feet, with a width of 150 feet, will require the dredging of 29,944 cubic yards of sand, at an estimated expense of $7,486.

Mill Bar and Rock.—Since the change in the channel on this bar, the rock is no longer a serious obstacle to navigation, and a buoy to point it out would be all that is necessary.

The channel now runs on the east side close to the bank, and the river spreads out over a large flat. Formerly the channel ran down the west bank and between Pope's Flat and Long Island, but this survey has developed a new channel, which is generally used now.

The least water in the new or east channel is 4 feet, and that only for a short distance. A little assistance of nature by dredging would probably, in a short time, produce a good 7-foot channel at low water. I should recommend that the present channel along the bank be followed in any attempt to improve navigation at this point. To make a channel 150 feet wide, with a mean depth of 7 feet, will require the dredging of 22,000 cubic yards of sand, at an estimated expense of $5,500.

RECAPITULATION OF ESTIMATES.

Sow and Pigs Reef	$4,000
Dredging Two-Mile Island Bar	4,000
Dredging Crofut's Bar	1,500
Dredging Drew's Bar	7,486
Removing Drew's Rock	2,000
Dredging Mill Bar	5,500
	24,486

The banks of the river from Derby down to the bridges are of rock and compact gravel, and can be considered as permanent banks, not liable to wash or be disturbed which I consider a point very much in favor of dredging operations, as the material forming these bars has all been brought down by the water (mostly in freshets) from the upper part of the river. The completion of the stone dam across the river at Derby will effectually prevent any large amount of deposit from above. In making these surveys I have been assisted by Mr. Charles E. Plumb, of Bridgeport, a competent surveyor.

I remain, very respectfully, yours,

W. S. EDWARDS,
Civil Engineer.

General G. K. WARREN,
Major of Engineers and Brevet Major General, U. S. A.

T 15.

SURVEY AND IMPROVEMENT OF BRIDGEPORT HARBOR, CONNECTICUT.

A report on the former surveys of this harbor was made by me, January 12, 1871, and is printed as part of H. Ex. Doc. No. 60, Forty-first Congress, third session. Congress appropriated for this improvement, in the act approved March 3, 1871, $20,000.

In my former report I state the uncertainty existing in regard to the operation of natural causes at this place. The recent map made under direction of Colonel Houston in 1866-'67-'68, shows a considerable greater depth in the channel and elsewhere than as it is on the map made by Lieutenant Blake, United States Navy, in 1837. I have found since that the copies of Lieutenant Blake's map in this office stated erroneously that the soundings on it were reduced to mean low water. It should have been stated mean low water of spring tides. On this account 1.1 feet should be added to the soundings on Blake's map if it is to be compared with a map showing soundings reduced to mean low water. The published United States Coast Survey chart of this harbor, though stated to be made from Blake's survey, shows about 2 feet greater depth on the bars than the manuscript copy. I have referred the matter to the assistant in charge of the United States Coast Survey Office, and he is unable to explain the difference, and regards the manuscript map which I had as more correct.

I have had a most careful survey made this season by Mr. W. S. Edwards. By a comparison of this map with Blake's it appears that the curve of 6 feet depth at mean low water outside of the bar is almost precisely the same now as it was in 1837, and any dredging done in 1838 or since on the outer bar has been filled up again.

There seems to be, too, but little more depth on the inner bar than there was in 1837, but the channel-way is somewhat wider.

The result is to confirm me in the opinion that no permanent increase of depth to the entrance of this harbor can be had by dredging till a sea-wall is built on the east side, to arrest the motion of the sand and gravel on its westward movement across the mouth of the harbor. The least estimate submitted by me for this purpose, and doing the necessary dredging for a channel 14 feet deep at mean low water, and 100 feet wide, was $124,000, and I thought it probable that a satisfactory improvement would cost from $361,000 to $567,000.

The appropriation of $20,000 which has been made, it is proposed to expend partly in dredging and partly in building a riprap sea-wall a short distance out from the shore, so as to test its effect to a limited extent in arresting the movement of the gravel and sand along the beach.

Advertisement for proposals to do this work was duly made, and the following is an abstract of the bids received.

Abstract of proposals for improving Bridgeport Harbor, Connecticut; received at the Engineer's Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and addresses of bidders.	Excavating, per cubic yard.	Granite placed in jettee, per ton.	Commence.	Complete.	Remarks.
Francis H. Smith, 121 and 123 Front st., New York.	$0 23 4	$3 14	....	....	
Morris & Cummings, New York City.	23.5	....	June 20, 1871	Aug. 20, 1871.	
H. U. & A. J. Beardsley, Bridgeport, Conn.	23.5	....	June 20, 1871	....	
S. F. Shortland & Bro., 106 Wall street, New York.	24	....	On or before the last of June, 1871.	As soon as possible.	
C. C. Campbell, 104 and 106 John street, New York.	27	2 84	July 1, 1871	Jan. 1, 1872	Bid informal, not in duplicate, and not accompanied by guarantee or copies of specifications.
Emory R. Seward, Albany, N. Y.	30	....	Aug. 1, 1871	June 1, 1872	
E. G. Brown, Elizabethport, Union County, N. J.	40	....	June 15, 1871	June 1, 1872	
W. M. Tebo, 16 South street, New York.	41	....	July 1, 1871	....	
John Flannell, post office box 5049, New York.	....	2 90	Aug. 1, 1871	As soon as the elements will permit.	Guarantee incomplete in not having a certificate that the guarantors are responsible parties.
Sylvester D. Hill, Greenwich, Conn.	....	2 95	30 days after acceptance of bid.	....	Guarantee incomplete, in not having a certificate that the guarantors are responsible parties.
John Beattie, Stony Creek, Conn.	....	7 50	....	....	Bid informal, not in duplicate, and not accompanied by guarantee or copies of specifications.
Dawson, Tank & Company, New London, Conn.	....	$2 50 for each ton of 2,240 pounds.	July 15, 1871	Jan. 1, 1872	Not considered, it having been received at 9.50 a.m., Wednesday, June 7, 1871, after the bids had been opened.

I certify that the above abstract is correct.

G. K. WARREN, Major of Engineers.

The contract for dredging was awarded to Francis H. Smith, of New York, and for the riprap sea-wall to C. C. Campbell, of New York.

The dredging has been in operation during July and August, and a shoal removed from the channel opposite Cook's Point, and work commenced on a lump in the channel at the inner bar, where there was less than six feet at mean low water.

The sea-wall will be put in as far as advisable this autumn.

I would recommend an appropriation for the next fiscal year of $100,000.

Bridgeport is a port of entry and is in the Fairfield district. The revenue collected there during the fiscal year ending June 30, 1871, was $7,193 96.

I append my previous report to this one.

T 16.

ENGINEER OFFICE UNITED STATES ARMY,
Newport, Rhode Island, January 12, 1871.

GENERAL: I have the honor to submit the following report of the survey of Bridgeport Harbor, Connecticut, which I was directed to make by your letter of instruction dated July 21, 1870.

This survey was authorized by section 2 of the act making appropriations for the improvement of rivers and harbors, approved July 11, 1870. At the same time the surveys of six other rivers and harbors were directed by you to be made by me, authorized by the same act of Congress. The amount allotted to make these surveys was limited to $6,000, and it required great care and economy to make this money hold out for all the places.

The first thing I did was to collate all the information of former surveys that I could obtain, and for this harbor nearly all that was extant was in this office, having been already collected or prepared by my predecessor, Major Houston, United States Engineers.

The oldest map of Bridgeport Harbor in my possession is that made in 1837 by Lieutenant Blake, United States Navy, assistant on the United States Coast Survey. This map is on a scale of 1 to 5,000. It shows that at that time there was but 5 feet at mean low water on either the outer or inner bars. In 1836 an appropriation was made by Congress amounting to $10,000 for improving the entrance to the harbor, and work was begun in 1838.

Captain W. H. Swift, United States Engineers, examined this work in September, 1838, and by it a channel-way 60 feet wide and 8 feet deep was dredged across the *outer* bar. No work was done with this appropriation on the *inner* bar. Captain Swift, in his report dated September 26, 1838, says the result of the operation has been "highly satisfactory, for, on the 8th instant, it was carefully sounded by Captain Brooks, of the steamer Nimrod, and was found to be 12 feet deep at low water, four feet deeper than it was left by the dredge."

Captain Swift, in his report dated September 8, 1839, says:

> No appropriation having been made by the last Congress, nothing, of course, has been done. The highly beneficial results which were stated in my last report are confirmed by the additional experience of another year.

Captain Swift made an error in stating there had always been 6 feet on the inner bar, for Blake's map shows only 5 feet, and I cannot help thinking that much of the favorable result he reports arose from the soundings being made at a stage somewhat above mean low water, and not properly reduced to low water. The next appropriation for deepening this entrance was $10,000, in 1852. The execution of the work fell to the charge of Captain George Dutton, United States Engineers. He made quite an elaborate report upon this harbor. It is dated December 11, 1852, and is printed with the documents accompanying the President's annual message in 1853. Captain Dutton thought that since Blake's survey there had been no change of depth at the inner bar, but the channel over the outer bar, which had been dredged in 1838 as before stated, had in 1852 a depth of only 6 feet at mean low water, and a width of about 90 feet. The channel dredged in 1838 had become widened about one-half, and had filled up to within one foot of the original depth.

Captain Dutton, however, regarded the result, as a whole, favorable to a continuation of the plan of dredging as a means of improving the entrance. He did not think there was need of any structures to prevent the drift of sands along the shore, as in his opinion this was inconsiderable in amount, and such as it was came from the westward.

Captain Dutton describes the outer bar, which is about one and three-fourths miles from the city, to be "composed of coarse and tolerably compact sand. The inner bar, distant about 700 yards inside the former, is composed of coarse compact gravel, except on its southern or lee side contiguous to deep water, where it is sandy."

Captain Dutton thought that a channel-way 200 feet wide, of a depth of 8 feet at mean low water, would, in view of the mean rise of the tide being 6.6 feet, while that of the spring tide was 8.8 feet, be sufficient to accommodate the commerce of the port at that time. He first estimated that to make this over the outer and inner bars would cost $22,000 in addition to the $10,000 then on hand.

Dredging work was carried on under Captain Dutton in the seasons of 1853–'54, and 27,649 cubic yards removed. He says, in his report of October 20, 1854:

> A channel has been excavated through the inner bar 100 feet wide and about 320 yards in length, to a depth at low water varying from 8 to 13 feet, and through the outer bar a cut has been made 60 feet wide, and about 260 yards long, and to a depth at low tide from 8 to 13 feet.

On the conclusion of this work he estimated that $14,000 additional, instead of $22,000, before reported, would be enough to make the new channel 200 feet wide.

Captain Dutton's reports and maps accompanying them give a very thorough idea of what he did, and of his views in the matter. In referring to the work on the outer bar in 1838 he says:

> How far this cut was carried cannot be satisfactorily ascertained, as there is much obscurity in the official record concerning the matter.

I think, as I have already said, that the benefit of the work done at that time was not as great as Captain Swift was led to report that it was. I cannot agree with Captain Dutton's opinion about the drift of sand along the shore, and I shall again refer to this matter further on in this report.

The next operation at Bridgeport Harbor was a survey made by Mr. George Beckwith, civil engineer, in 1866, under direction of Colonel Houston, United States Engineers, "to ascertain the present state of the harbor and the extent of the encroachments on it by the action of the tides." The report of this is found in House Ex. Doc. No. 56, second session Thirty-ninth Congress, page 119, and in the appendix, pages 199, 200, 201, and 202. The map of the survey, on a scale of 1 to 5,000, is in this office. Colonel Houston states that the depth on the bars was 9 feet at low water, and was as good as when excavated. (The report of the Chief of Engineers, page 20, document last quoted, says: "No reference is made by the officer in charge to the work done under this appropriation of 1852." Though Colonel Houston does not do so specifically, yet he must have had it in his mind, for that was the only time there was any dredging done upon the inner bar.)

The principal object of Colonel Houston's survey was to ascertain the amount of encroachment upon either the natural or artificial channels by a deposit of sand brought along the shore and deposited on the bar, and also the location and extent of suitable works to arrest this action, should it be shown to exist.

The result of the survey, however, was such that Colonel Houston did not think there was any danger to the harbor from the cause stated sufficient to warrant the construction of the proposed barrier to the movement of the sand. He recommended that nothing be done except to make surveys in succeeding years to still further elucidate the matter and determine the changes to which the bars and sand-spits at the entrance to the harbor were subjected.

In 1867 Colonel Houston had Mr. Beckwith make a survey of Long Beach, lying east of the harbor, and some other observations about the deposits at the northwest end of the beach. The result did not indicate anything to make a change in the recommendations Colonel Houston had previously made.

In the summer of 1868 Colonel Houston again had a survey made by Mr. Beckwith of the outer and inner bars and of Long Beach, and an estimate of the strength of the currents. The map of this last survey, on the scale of 1 to 5,000, is in this office. This map shows more water on the bars than existed in 1866.

A report in relation to the effects of the currents about Bridgeport Harbor was made to Colonel Houston by Captain A. H. Holgate, United States Engineers, December 19, 1868, which is printed with Colonel Houston's report in the annual documents accompanying the President's message for 1869.

The maps made by Mr. Beckwith are not very neatly drawn, and there may be some want of precision in the determinations, but, on the whole, the result seems very satisfactory. They indicate that nearly all the deepening caused by the dredging under Captain Dutton's direction, in 1833–'34, has been permanent, and sustained the views advanced by him. The result seems to be almost too good to be true, yet in face of the evidence, it does not seem justifiable to deny it.

I have had all the surveys assembled on one sheet, so as to exhibit at one view the form of the channel-way at the different times when the surveys were made, and, after careful consideration, I concluded it was not necessary to make any further surveys at present, for there being so much demand for the money for surveys at places where we had no information, it seemed incumbent on me to use the money to survey places where we had no knowledge, especially as we knew enough of Bridgeport to design and estimate for any improvement desired. I send with this report the consolidated map which I have prepared. The number of lines appear confusing at first, but the different years' work can, with a little scrutiny, be distinguished by the different colors in which they are drawn. There is a want of coincidence in the different surveys, which leave it somewhat a matter of doubt whether the changes in lines of equal depths of water in different years are the result of the actual changes on the bars themselves, or arise from a difference in the surveys. The important matter that seems to be determined by these last surveys is that the water is from 2 to 3 feet deeper on the bars now than in 1837. This may possibly result from an error in reducing the soundings to mean low-water level, and the first thing to be done, if Congress appropriates money for the improvement, is to verify the results of Mr. Beckwith's survey.

Upon visiting Bridgeport, and conferring with the business men of that place, I learned that they did not want a plan merely to preserve the harbor and entrances as it is, but they wanted the channel-way over the bars and up to the city wharves deepened, so as to have a channel at least 100 feet wide and 14 feet deep at mean low water, or 12 feet deep at extreme low water, with such protection against drifting sand as the Engineer Department thought beneficial. I have accordingly prepared the following estimate of the amount of material necessary to be excavated to accomplish this and make a channel 100 feet wide and 14 feet deep at mean low water, and its probable cost. I have allowed 50 per centum (according to Captain Dutton's experience) over the quantity calculated from the actual measurements:

To excavate through the outer bar, 100 feet wide, 14 feet deep at mean low water, 34,000 cubic yards, at 30 cents per cubic yard	$10,200
To excavate through the inner bar, 3,600 cubic yards, at 30 cents per cubic yard	10,800
To excavate from deep hole above inner bar up to Mather's wharf, 91,800 cubic yards, at 30 cents	27,540
To excavate from Mather's wharf up to bridge, 68,200 cubic yards, at 30 cents	20,460
Total	69,000

I am satisfied, however, that the channel should be at least 200 feet wide, which would double the excavation, and cost $138,000.

On the matter of the drifting of the sand along the shore there is much to say. Captain Dutton thinks that if there is any motion of the sand here, it is from the west eastward. Captain Brooks, of Bridgeport, one of the most experienced navigators in the sound, is of the opinion that there is a large amount moved along the shore, some from the west, but more from the east. This latter direction (*i. e.*, from the east) is that the sand generally takes along the shores of the sound. This is demonstrated beyond question at the mouth of the Connecticut River, at the breakwater at Southport, at Cedar Point, (Westport,) and at Port Jefferson Harbor, and many other places.

The moving littoral sand is generally small-sized grains. In general the depth of water on a bar is the result of an equilibrium established among forces that have been long in action, and if we change this normal state of things, nature will more or less rapidly restore the original status. The bar, however, may have grown by exceedingly small increments of coarse material, sorted out and left behind by the moving current which moved away the lighter portions. In one or two cases along the sound this can be demonstrated to be the natural action. In such case the coarse material which the dredge would remove could not be rapidly supplied, and the power of the current might be sufficient to remove such fine material as from any cause might be brought into the channel. It is only on such grounds that I can account for the excavated channel at Bridgeport remaining so low.

From such study as I have been able to make of the Long Island Sound generally, and of the map of Bridgeport, I am confident there is a considerable movement of sand westward across this harbor, and that, *unless something* else is done, dredging out the required channel will *be too temporary* a benefit to warrant so great an expenditure. I would, in confirmation of my views about the movement of the sand, refer you to the accompanying map. You will see that Long Beach has been extended northward in the face of the current coming out of the Gut Channel on the ebb tide, till that channel has been curved to the northward, and the main land is being abraded on the north side of the channel. The strength of the current from the Gut Channel forces that coming down from Bridgeport to the west side of the main entrance, and into a southwest direction, till it meets the ebb tide in the sound, when the resultant takes a southward course. This natural channel-way into Bridgeport is so evidently formed by discernable influences, and is so evidently the result of the action of the currents, that I have laid out the channel to be dredged to correspond with its deviation; for, although a straighter channel would be better, unless something is done to change the course of the current, it would not be kept open.

The same kind of operations so successfully employed on Lake Michigan I consider applicable to Long Island Sound, but the teredo, or ship-worm, prevents our making as cheap use of wood as is done in the fresh water.

A breakwater built from Long Beach southwest to the line of deep water, (see section on the map,) would, in my opinion, be a good work, by stopping the drift of the sand and concentrating the action of the tides upon the channel, and I have prepared an estimate for it, which is given at the end of this report. Such a structure, however, would be very expensive, and as it would not be sufficiently valuable as a shelter for vessels in storms to justify such an outlay, I have tried to devise some other way of arresting the motion of the sand and increasing the action of the tide in keeping open the channel-way. This I propose to do by driving piles, arranged in the form known as dolphins, along the line above spoken of, as the one for the breakwater. The object of these clumps of piles is to check the motion of the tide and cause the sand to be deposited near them. I believe this will answer the purpose. The piles are to be creosoted. At the shore end there must be a wall of stone, built up to high-water level, of width equal to its height, extending from the shore out 100 feet beyond the line of extreme low water. This wall is to stop the motion of the sand carried along the shore by the heavy rollers from the southeast. An estimate of the line of dolphins and wall are given at the end of this report.

Bridgeport, Connecticut, is now one of the most flourishing places along the sound. Its trade and manufactures are large, and there is a population of 20,000. It lies on the New York & New Haven Railroad, and it is the terminus of the Housatonic Railroad and Naugatuck Railroad.

From a statement sent me by a committee of residents at Bridgeport, (forwarded with this report,) it appears that the number of arrivals and departures of vessels in the nine months preceding February 12, 1870, is upwards of 5,000, of which 120 were engaged in foreign commerce, contributing directly to the revenue of the Government. A considerable portion of the foreign business of the place has to be done in New York and New Haven, for want of sufficient depth of water on the bar to allow large vessels to enter. The depth, according to the statement of Captain John McNeil, is now, at extreme low water, not more than 5½ or 6 feet, but at high tide there is about 16 feet.

Bridgeport is a port of entry, and is in the collection district of Fairfield, Connecticut. The amount of revenue collected in the fiscal year ending June 30, 1870, was $12,164 40. I refer you to a communication from the collector, sent herewith.

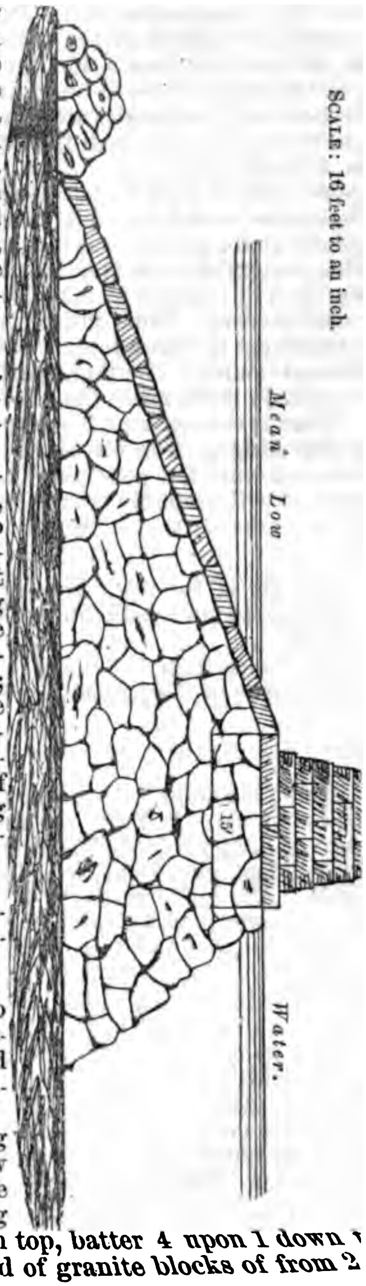
Bridgeport Harbor is in the third light-house district. There is a

beacon-light at the entrance to the harbor. The nearest light-
at Black Rock harbor, about three and one-half miles south
Bridgeport. Incidentally I would mention that Black Rock
upon which the United States expended $20,550 in 1836-'37-
very insufficient harbor of refuge, and has filled up very muc
that time. It is thought that an additional sea-wall should be
connect the north end of Fairweather Island with the main land, and a breakwater about one mile long northeast from the "*Cows.*" This latter would be a very expensive work, but would form a first-class harbor of refuge.

There is also a light-house on Stratford Point, about five and a half miles east of Bridgeport, and a light-ship at the Middle Ground, about nine miles south-east from Bridgeport.

Annexed to this report are—

1. A map, on scale of 1 to 5,000.
2. Communication from Collector J. S. Hanover, dated September 24, 1870.
3. Communication from a committee of citizens of Bridgeport, containing copy of a petition to Congress; a statement of merchandise received at Bridgeport for the nine months preceding February 12, 1870, and of the number of arrivals and departures of vessels in the same period; an abstract of the evidence before the House Committee on Commerce, and a statement of Collector Hanover, of the number of vessels arriving and departing from January 1, 1870, to December 31, 1870.



Estimates for different kinds of improvements at Bridgeport, Connecticut.

First. For stone breakwater to arrest motion of the sand and prevent its filling the excavated channel, and to increase the action of the tide in the channel.

Section of breakwater.—Spring tides rise 9 feet above mean low water. The top of the wall to rise 2 feet above high water of spring tides. Wall to be 6 feet wide on top, batter 4 upon 1 down
above low water, to be composed of granite blocks of from 2

yards each, of a thickness from 18 inches to 2 feet, to be doweled throughout with gun-metal dowels, and top course securely clamped with wrought iron of suitable size, (cost say $25 per yard.) This wall to rest on a bed formed by throwing in large irregular blocks of stone, of not less than 1¼ tons weight, having a slope seaward of 1 upon 3, and shoreward of 1 upon 1, and to be 15 feet wide on top at level of mean low water. This foundation to be brought to even surface by small angular stone, and paved on the sea-slope with large granite blocks 1½ feet thick and not less than 2 tons weight, clamped with wrought iron. The foot of the paved slope to be protected by large riprap stone, same as for the body of the breakwater, to contain about 4 cubic yards per linear yard of breakwater. All the riprap to cost, say $6 per yard, the pavement $25 per yard.

The above wall is proportioned so as to be about the same cost as a rough breakwater would be, made of the same height, namely, 11 feet. As the height increases, there is a great saving in combining them as I have. This particular form is adopted as the basis of calculation. It may be modified in practice as may be necessary. The body of the work may not need paving. From the experience with the sea-wall at Southport, the thickness of wall adopted will be sufficient to stand the waves of Long Island Sound. The Southport sea-wall is 9 feet above ordinary low water, and it is thought that 2 feet additional height should be given it. That is the reason a height of 11 feet is taken above mean low water for this design. The waves, in heavy storms and high tides, will break over such wall, but not enough to cause any swell, and if the wall be well built it will probably stand the shock. However this wall may answer, it is probable that a lighter structure of stone should not be adopted.

To build the body of the work from the mean low-water line out to the 6-foot curve, a distance of 933⅓ yards, 6,415 cubic yards, at $6	$38, 490
To build the same from the 6-foot curve out to the 14-foot curve, a distance of 266⅔ yards, 10,648 cubic yards, at $6	63, 888
Total	102, 378

To pave the outside slope with large split blocks fitting each other and clamped. 1. From the shore out to 6-foot curve, a distance of 933⅓ yards, 1,300 cubic yards, at $25	$32, 500
2. From the 6-foot curve out to 14-foot curve, a distance of 266⅔ yards, 1,430 cubic yards, at $25	35, 750
For riprap at foot of paved slope, 4 cubic yards for each linear yard, 933⅓ yards, out to 6 feet depth, 3,733 yards, at $6	22, 398
For the same riprap for 266⅔ yards between 6-foot and 14-foot curve, 1,066 cubic yards, at $6	6, 396
Solid masonry wall 11½-foot base, with lower course projecting 1½ feet each side, 11 feet high, batter each side 4 upon 1, making top width 6 feet, built of large rough-hewn rectangular blocks. Area of section 11¼ square yards, giving 11¼ cubic yards for each linear yard of breakwater:	
To extend from shore out to 6-foot curve, a distance of 93⅓ yards, requiring 10,500 cubic yards, at $25 per yard	262, 500
To extend the wall to 14 feet depth, requires an additional length of 266⅔ yards, requiring 3,000 yards, at $25	75, 000

SUMMARY.

1. From shore out to 6 feet depth, distance 933⅓ yards:

For rough breakwater blocks of 1¼ tons and upward, slope outside 1 upon 3, inside 1 upon 1, 15 feet wide on top, 6,415 yards, at $6 per yard	$38, 490
For top wall, to rise 2 feet above high water of spring tides, (11 feet high,) 6 feet wide on top, batter 4 on 1, built of large blocks cut to shape and doweled, 10,500 cubic yards, at $25 per yard	262, 500
To pave the outside slope with large split blocks fitting each other and clamped, 1,300 cubic yards, at $25 per yard	32, 500
For riprap at foot of paved slope, 3,733 cubic yards, at $6	22, 398
	355, 888

2. From 6-foot curve out to 14-foot curve, 266⅔ yards:

For body of breakwater as before, 10,648 cubic yards, at $6 per yard	$63, 888
For top wall as before, 3,000 cubic yards, at $25 per yard	75, 000
Pavement of outside slope as before, 1,430 cubic yards, at $25 per yard	25, 750
Riprap at foot of slope as before, 1,066 cubic yards, at $6 per yard	6, 396
	181, 034

Light-house at end of breakwater	$30, 000

GRAND TOTAL.

Breakwater complete out to 6-foot curve	$355, 888
Breakwater complete from 6-foot to 14-foot curve	181, 034
Light-house	30, 000
	566, 922

It is probable that the outside paving slope and riprap at its base could be dispensed with, and the whole breakwater would then cost—

From shore out to 6-foot curve	$323, 380
From 6-foot curve to 14-foot curve	144, 284
Light-house	30, 000
	497, 664

If the breakwater be built out only to the 6-foot curve, a beacon can be substituted for the light-house, and the cost will be—

For breakwater	$355, 888
For beacon	5, 000
	360,888

As before stated in the body of this report, it may be that the expense of the breakwater may not be justified for the objects to be accomplished at present, and I have made the following estimate for a row of dolphins from the low-water line, out to the 6-foot curve, a distance of 2,600 feet. These are to be constructed in groups of five piles, 8 feet apart, making 325 dolphins, at $100	$32,500
Four hundred feet of dry wall between high and low water line, about 15 feet wide on bottom, and 8 feet wide on top, rising 11 feet above mean low water, average height 6 feet; top and bottom courses to be of split granite, 8 feet long and 2 feet thick, the whole requiring 1,022 cubic yards of stone, at $12 per yard	12,264
Six hundred and fifty yards of riprap stone to place around dolphins and end of wall, at $6 per yard	3,900
	48,664

My recommendation, therefore, is now to appropriate enough money to build the line of dolphins and shore jettee and dredge a channel 14 feet deep, at first 100 feet wide. This requires the following amount:

For dredging	$69,000
For jettee and line of dolphins	48,664
For superintendence	6,336
	124,000

To make the channel 200 feet wide and 14 feet deep, will require, in addition, for dredging	$69,000
For superintendence	3,000
Total	72,000

Yours, respectfully,

G. K. WARREN,
Major of Engineers, Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

BRIDGEPORT, CONNECTICUT, *January* 3, 1871.

SIR: I am informed by Messrs. Dunham and Nickerson, members of special committee of city of Bridgeport on harbor improvements, that you desire a copy of petition of citizens to Congress, and also of such statistical items and evidence as was presented by said committee before the committee of Congress, in aid of their application for an appropriation to improve the harbor, with a view of making some use of them in your report. You also expressed a similar request in your note to me of December 10, which, allow me to say, would have been forwarded to you before, but for the expectation on my part, derived from letter of said date, and also from your letter to Messrs. Barnum and Kellog, of December 20, that you would soon visit Bridgeport personally, and, by appointment, have an interview with the committee, when a more general interchange of views could be had, &c. Not having received any notice of your intended visit, no opportunity was given for calling the committee together to meet you, and, unfortunately, a majority of the committee were absent, and did not have that pleasure. We believe, however, that the interview had with the members of the committee above referred to resulted in a more full and correct understanding of the wants of the harbor, and of the purpose and wishes of the citizens and the committee in respect to the appropriation asked for, and the direction in which it should be applied, than before existed. In short, "that the application of the city of Bridgeport is for an appropriation to widen and deepen the channel of Bridgeport Harbor from the outer bar inwardly, to admit vessels of larger draught, commensurate with the present and prospective commercial importance of the port," leaving all questions as to its future protection by breakwaters, jettees, or other means, (whether necessary or not,) to the judgment of the Engineer Corps, without suggestion or comment that would embarrass the main question.

I therefore inclose herewith a copy of the original petition, signed by over 1,800 of the business men and property-owners of the city. (The item of 12 feet is intended to mean at lowest tide.)

I send also the exhibit A, B, C, taken from the collector's books at that time, which, I presume, covers all the necessary ground. If later statistics are required, they will be furnished on notice from you to that effect. I also send extracts of evidence marked D, given before the committee at Washington.

In closing, I desire to say that the entire population of the city feel a deep interest in the success of the application, and we trust you will find reasonable and sufficient ground for recommending that a liberal appropriation be made for thorough excavation of the channel, &c.

Respectfully, yours,

F. HURD,
Secretary of Special Committee on Harbor Improvements.

G. K. WARREN,
Brevet Major General.

COPY OF PETITION OF CITIZENS OF BRIDGEPORT TO CONGRESS FOR IMPROVEMENT TO HARBOR OF BRIDGEPORT.

To the honorable Senate and House of Representatives in Congress assembled:

The petition of the undersigned citizens, of the city of Bridgeport, in the State of Connecticut, respectfully represents:

1st. Said city is situated upon both sides of Pequonnock River, near its entrance into Long Island Sound. It has a population of 20,000 inhabitants, which is rapidly increasing, and is largely engaged in manufactures. It is the terminus of the Housatonic and Naugatuck Railroad, and the New York and New Haven Railroad passes through it.

2d. The harbor of said city consists of the Pequonnock River, and an arm of Long Island Sound. At the point where this channel connects with the Sound, a sand-bar has been formed by the combined action of the tide and the water from Pequonnock River. The result is, that the channel has become so filled up that the great majority of vessels cannot enter the port of Bridgeport, except at high tides, and very many vessels require to be lightened to come in at high tide, causing great delay and expense.

3d. The number of vessels, steam and sail, which arrive at this port in the course of twelve months is upward of 3,000, of which number no inconsiderable portion is engaged in foreign commerce, contributing directly to the revenue of the General Government.

4th. Your petitioners, therefore, pray that an appropriation may be made to remove said sand-bar and to widen and deepen said channel and harbor, in order that vessels drawing 12 feet of water may be enabled to enter without being grounded, and without the aid of lighters.

NOTE 1.—The petition, of which the above is a copy, was signed by over 1,800 names, with certified copy of the resolutions appointing the committee, was presented to Congress by Hon. W. H. Barnum, member of Congress of the fourth district.

H. HURD,
Secretary of Committee.

NOTE 2.—The committee were heard before the committee of Congress, March 9, 1870, and presented a statement of the commerce of the port, &c., &c., and in resolution of Congress, passed June 13, 1870, a preliminary examination, with a view to an appropriation, was ordered for the harbor of Bridgeport.

F. HURD,
Secretary of Committee.

A.

Statement of merchandise received at the port of Bridgeport during nine months ending February 12, 1870, in sail-vessels, barges, and canal-boats.

Lumber, feet	29,556,000
Shingles, feet	3,952,000
Laths, feet	4,052,000
Spokes	40,000
Wood, cords	1,167
Brick	6,877,000
Building-stone, tons	3,966
Flag-stone, feet	38,100
Cement, barrels	15,500
Molding-sand, tons	3,183
Nails, kegs	5,804
Coal, tons	91,432
Pig-iron, tons	23,582
Iron, old, &c., tons	947
Iron and steel rails, bars	18,706
Grain, bushels	131,038
Apples, barrels	5,150
Salt in bulk, pounds	3,477,750
Salt in sacks, sacks	2,915
Plaster, tons	9,874
Grindstones, tons	522
Vitriol, carboys	2,105

Also, not included in the above: 221 cargoes assorted merchandise per sailing-vessels; 397 cargoes assorted merchandise per steam-vessels.

B.

Statement of the number of arrivals and departures (steam and sail) at port of Bridgeport, for the nine months ending February 12, 1870.

Arrivals.	No.	Departures.	No.	Total.	No.
Steamers and tugs	487	Steamers and tugs	487	Steamers and tugs	974
Schooners	881	Schooners	881	Schooners	1,762
Sloops	447	Sloops	447	Sloops	894
Canal-boats	127	Canal-boats	127	Canal-boats	254
Barges	83	Barges	83	Barges	166
Brigs	32	Brigs	32	Brigs	64
Total	2,057	Total	2,057	Grand total	4,114

C.

Statement of the number of arrivals from foreign countries, and the amount of duties collected from all sources at port of Bridgeport, for the ten fiscal years from July 1, 1859, *to June* 30, 1869.

Years.	Number of arrivals from foreign countries.	Amount of duties collected from all sources.	Amount received from tonnage dues.	Total receipts.
July 1, 1859, to June 30. 1860	38	$183 81	....	$183 81
July 1, 1860, to June 30, 1861	37	542 82	....	542 82
July 1, 1861, to June 30, 1862	28	1,173 90	....	1,173 90
July 1, 1862, to June 30, 1863	17	1,853 70	....	1,853 70
July 1, 1863, to June 30, 1864	25	3,076 35	$912 48	3,988 83
July 1, 1864, to June 30, 1865	17	3,275 87	1,397 46	4,673 33
July 1, 1865, to June 30, 1866	42	3,663 82	3,232 68	6,896 50
July 1, 1866, to June 30, 1867	60	10,762 41	3,513 33	14,275 74
July 1, 1867, to June 30, 1868	71	42,474 67	3,430 47	45,905 14
July 1, 1868, to June 30, 1869	66	30,412 86	3,951 92	34,364 78
	401	97,420 21	16,438 34	113,858 55

D.

EVIDENCE BEFORE CONGRESSIONAL COMMITTEE.

John Brooks.—Had been acquainted with harbor sixty years. Business had increased rapidly the last ten years; 13 feet is the greatest depth of high water; 6½ to 7 feet, average depth at low water on the bar, and it runs shoal all the way up to the docks. There is an outer and inner bar. Thinks it necessary to dredge from the outer to the inner bar. It is soft mud. Harbor is as good as it was in 1837, but we want it better, so that a larger class of vessels can come into the harbor.

Captain John McNeal, of steamboat line.—Has been acquainted with the harbor for many years; running vessels since he was a young man. At lowest tides there is not over 5½ to 6 feet on the bar. There are deeper places in the bed of the river. Steamboats drawing 6 feet drag on the bar at low water. The water is too shoal to accommodate as large a class of steamboats as the business of the place requires. Plaster and foreign coal vessels cannot get into the harbor without lightering.

Ex-Mayor Hawley.—Was formerly engaged in importing sugar and molasses, but owing to the light draught of water was obliged to give the business up. It was in contemplation to build a large steam sugar-refinery if any improvement can be made in the harbor. The commerce of the city would be very much improved if the harbor were deepened as contemplated.

E. F. Bishop, President of Steamboat Company and Naugatuck Railroad.—In 1860 we had about 12,500 inhabitants; we have now, (March, 1870,) about 22,000.

BRIDGEPORT, CONNECTICUT, *January* 5, 1871.

DEAR SIR: Since writing you yesterday, I have received a report, of which inclosed is a copy, of the number of vessels arriving and departing from this port for the year 1870. I forward it as an item showing the importance of the port, which may have some bearing favorable to our application, &c.

Respectfully, yours,

F. HURD,
Secretary of Committee.

General WARREN.

Report of J. G. Hanover, (collector Bridgeport district,) for year 1870.

The number of vessels which have arrived at the port of Bridgeport from January 1 to December 31, 1870—

Schooners	1,141
Steamers and tugs	527
Sloops	479
Barges and canal-boats	290
Brigs	9
	2,446
Number departed	2,446
Total number in and out of harbor	4,892

Estimated average tonnage, 125.
Gross amount tonnage at above estimate, 611,500 tons.

J. G. HANOVER.

F. HURD, *Secretary of Committee.*
JANUARY 6, 1871.

CUSTOM-HOUSE, BRIDGEPORT, *September* 24, 1870.

SIR: Your favor of the 23d instant is received, and contents noted.

The receipts at this port for the fiscal year ending June 30, 1870, were as follows:

Duties on imports	$6,349 40
Tonnage duty collected	5,053 02
Marine hospital dues	761 98
Total	12,164 40

I may here add that the coastwise trade of this port is constantly on the increase, as you will observe by the following account of arrivals for the first year for which I had the honor to be collector, commencing May 13, 1869, and ending May 13, 1870. The whole number of arrivals for this period was as follows:

Steamers and tugs	581
Schooners	1,080
Sloops	540
Canal-boats	183
Barges	91
Brigs	34
Total	2,509

It will be noticed, therefore, that the arrivals and departures from this port number 5,018. The number of foreign arrivals for the year was about 60, which, deducted from the above, will leave the coastwise arrivals and departures 4,898.

If there is any other information which you may need in regard to this port, it will afford me pleasure to comply with any request you may make, so far as it is in my power to do so.

Very respectfully, yours, &c.,

J. G. HANOVER, *Collector.*

Major General G. K. WARREN, *Newport, Rhode Island.*

T 17.

IMPROVEMENT OF WESTPORT HARBOR, CONNECTICUT.

The condition of this work on the 30th of September, 1870, is given in my last annual report, published with the report of the Chief of Engineers.

There was then available an appropriation of $2,500, made in the act approved July 11, 1870, but the last Congress made no additional appropriation.

During last autumn repairs were made to the sea-wall on Cedar Point, to protect the entrance to the Saugatuck River, on which Westport is situated, and about $1,913 was thus exhausted, leaving a balance now on hand of $587. It has so far seemed improbable that anything could be done with this small remainder, other than to make additional surveys. These seem especially desirable, not merely on account of the use they may be in continuing further improvements, but to enable us to see the effect of former works, built at this place by the United States many years ago, and which may afford valuable experience.

It is my design to give the place a more careful personal examination than I have yet been able to make, and I will then submit a project of what I deem the most profitable way to employ the $587 now available. I append to this report a report made to me by my assistant, Mr. H. N. Babcock, who superintended the work last year.

In 1827 a survey of the mouth of the Saugatuck River was made by Lieutenant Colonel John Anderson, of the Topographical Engineers. He recommended the straightening and deepening of the channel inside the bar, and the construction of a canal across the Great Marsh, on the west side of the river, so as to give an outlet to the Sound more direct than the natural channel. For doing all the work he recommended, he made an estimate of $6,128 65.

In H. Ex. Doc. No. 18, second session Thirty-ninth Congress, a statement is made of the following appropriations for this locality:

In 1827, removing obstructions at Saugatuck Harbor	$1,500 00
In 1836, for improving the harbor of Westport	3,000 00
In 1837, for improving the harbor of Westport	3,734 00
In 1838, for improving the harbor of Westport	4,782 00
	13,016 00

Captain W. H. Swift, Topographical Engineers, on September 26, 1838, states that the sea-wall on Cedar Point was completed in 1837, at a cost of $1,000. Captain Swift, in this report, states that the canal had nearly been excavated down to a depth of 2 feet at mean low water, and that a contract was about to be made to carry the excavation down to 4 feet below mean low. It had been found necessary to build a sea-wall on the east side of the Sound entrance to the canal, about 300 feet long, to prevent the sand from the beach closing the entrance up, and this, at that time, was nearly complete. He says the unexpended balance on the 1st of September, 1838, was $6,234, and that the United States agents then thought that this would be sufficient "to complete the works, including the removal of the two rocks." The foregoing is all the information in my possession in regard to the progress of the work.

The present condition of the canal is given in detail in Mr. Babcock's report, hereto annexed. The canal is in a very bad condition, and is practically dry at low water.

Mr. Babcock's estimate for putting everything in order is about $30,000.

This place is in the Fairfield collection district. Nearest port of entry is Bridgeport. Revenue collected there in fiscal year ending June 30, 1871, was $7,193 96.

ENGINEER OFFICE UNITED STATES ARMY,
Newport, Rhode Island, January 18, 1871.

SIR: I have the honor to submit the following report on the construction of a breakwater on Cedar Point, included in the plan for the improvement of the navigation of Westport Harbor, Connecticut.

This duty was intrusted to me by instructions dated October 28, 1870, and the work carried on in accordance with the following plan. Arriving on the ground, I found at the end of Cedar Point the old breakwater in a tolerable state of repair, while at the north or shore side of the point the wall was washed down to a level with the ground.

Beyond this old wall, toward the shore, the sea had cut a gulley about 40 feet wide. Beginning with the north side of this gulley, where the ground was higher, the work of rebuilding was to be carried as far into the old wall as it was tumbled down, a distance of 130 feet.

I reached Saugatuck, the nearest railway station, Friday, October 28, and after looking over the ground prepared to make a survey of the point. The contractor had left one load of stone, but had not sent on his workmen, so the first few days were devoted to the survey, including cross-sections showing the rise of the land, and the size and condition of the old wall. On the 10th of November I finished and sent to the office a tracing of this survey.

Sunday, the 6th of November, the second load of stone and the men arrived, and on the following day I staked out the work. The stone being laid too far below high water to be reached at all times of the tide, the pit for the foundation was first excavated, and with the first low tide the derrick raised.

The wall is built of split granite blocks, the foundation course being headers the full width of the wall, 8 feet, and weighing an average of 2½ to 3 tons each. The upper course was of stretchers, divided in most parts to a double course and averaging a ton each, except where smaller stones were required for filling and leveling. The stones were all bonded carefully, with a lap of 6 inches or over.

The entire work of construction, including the raising and repairing of the derrick, occupied thirty-eight days. The derrick used was an old one, and in quite bad condition, the mast being cracked and weak, and one of the wheels worn so as to slip, and finally the ends of three spurs broke. I then reversed the wheel end for end, and it lasted for the remainder of the work. When the work was nearly completed, the mast of the derrick broke by falling. I finished the wall, as far as our stone went, by hand-tackle, and after filling up a few spots in the old wall, dismissed the men. A rough batter is broken on the wall, as nearly as may be to 3 inches to the foot. The height of the wall is 5 feet, making the top width 5½ feet, though, on account of the difficulty of breaking, it often exceeded it.

The weather was almost uniformly pleasant, a day and a half being all the time lost from unpleasant weather. West winds prevailed during all the work, frequently quite strong and cold, and, toward the close of the work, occasional squalls of snow, but not enough to seriously interfere with the progress. The length of wall laid is 108 feet, amounting to 130 cubic yards. The new wall is 10 inches higher than the highest part of the old wall, and extends 43 feet 9 inches farther to the north toward the main land.

The north end is 1 foot 9 inches above the sand, and the south end 3 feet 5 inches. The difference of level from high-water mark to the top of the wall is 5 feet 9 inches. The weight of the full length of wall is 284 tons; and this, with an anchorage of 1 foot 7 inches at the minimum below the sand, is more than sufficient to hold its place. What has most injured the old wall is the cutting out of the sand on which it is based.

The foundation-stone average only 2½ feet in length, and have no level face for the upper course to rest on. Hence a trifling settling on one side pitches the upper courses over. The depth of anchorage, with the length of the foundation-stones and regular bonding of the joints, I consider an ample precaution against a like result in the new wall.

During my stay at Saugatuck, besides the survey of Cedar Point, I also made surveys, one locating the New York and New Haven Railroad bridge, and a bridge known as "the new bridge," and one showing the length and breadth of the canal through the Great Marsh. These I have plotted and drawn in the following manner:

A topographical map of Cedar Point on a scale of 250 feet to the inch, with the high-water line plotted first and low-water laid off by offsets. This map extends back as far as the Point is likely to be overflowed by highest water and shows the breakwater, the old part shaded and the new left blank, and the line of highest ground along the point. I have added to this a longitudinal section of the point extending along the line of highest ground and around the breakwater wall, to the end of the Point; also a section at the north end of the new wall perpendicular to its course. In these sections the horizontal scale remains the same, (250 feet to the inch,) and the vertical is exaggerated fifty times, (5 feet to the inch) To illustrate better the construction of the wall, I have made a side and end elevation and cross-section on a scale of $\frac{1}{48}$, showing the bounding of the courses and the batter.

A map of the canal, with soundings. The canal at the south end has a nearly level bottom, but at the north end the bank slopes in a curve to the middle. I took stations 80 feet apart, except at the south end, where I made two spaces of 200 feet and took soundings opposite all these stations. The bottom at 550 feet from the north end is covered with sea-grass, but the remainder is soft sandy mud. The greatest depth below low water is 5.3 feet. The least depth of the middle is 1.7 feet.

The map is plotted on a scale of 100 feet to the inch. I added to it a profile of the middle of the canal, referred to low-water mark. The vertical scale exaggerated 10 times, (*i. e.* 10 feet to the inch.)

A map of the railroad bridge and the new bridge, showing their length and location and the location of the piers and draws. I have marked out on this map the approximate course of the channel. The scale is 200 feet to the inch. The railroad bridge is a Howe truss, 460 feet 9 inches long, supported by four stone piers 4½ feet wide, and a draw-pier 30 feet wide. The direction of this bridge is north 74° 07′ east, crossing the river at an angle of about 10° from perpendicular to its course, and the available width of draw is 56 feet. There are starlings on both sides of the piers that limit the draw. The bridge is 32 feet wide, with two railroad tracks and a foot-path.

The new bridge is also a Howe truss, 290 feet long and 24 feet wide. It has five stone piers 4 feet wide and a draw-pier 20 feet wide, with an available width of draw of 48 feet. It crosses the river in direction north 69° 45′ east, and its least distance from the railroad bridge is 1,160 feet.

The following plans of improvement of the harbor are recommended:

At the south or sea end of the new part of the breakwater, the wall needs to be continued through a distance of 63 feet in length, where the old wall is in a nearly useless condition. For the further protection of the point, I would recommend setting out untrimmed cedar trees a short distance below high water; this to be continued along the shore for a length of 300 feet, beginning a short distance south of the shore end of the wall and running north, the trees to be set at intervals of 3 feet. The cost of this improvement I estimate as follows:

For building the wall, 63 feet in length, and cross-section the same as that recently built, 78¾ cubic yards, at $10 per yard	$787 50
Necessary excavation, 93⅓ cubic yards, at 40 cents per yard	37 33
100 cedar posts, at $1 apiece	100 00
Total	924 83
For removal of loose rocks in the channel	500 00

To render the channel of any use, it must be dredged to the depth of 5 feet below low water, and protected from further filling. This protection will require the following:

A wall, built of light, sharp, split stone, 1,329 feet long, 13 feet high, 4 feet wide at base, 3 feet at top, with a coping of good split stone, one foot thick, lying entirely across the wall and 3 feet beyond; the wall to be backed by an embankment of earth, (that obtained from the dredging will do,) 12 feet wide on the top, with a slope of 1½ to 1, and riprapped with rough stone, which can easily be obtained in the neighborhood.

Along the wall, and equally separated, seven stone piles, for vessels to fasten to and pull off by when grounded. These posts to be of granite, 11 feet long, 16 inches diameter above ground, 3 feet high, and trimmed round, with top hemispherical; the remaining 8 feet rough, and sunk in the bank, 11 feet from the edge. The west bank will need to be cut to a slope of 1 to 1, and paved with sharp stone, or else cut away to a slope of 2 to 1.

The cost of this work I estimate as follows:

For dredging and cutting away the west side, 9,197 cubic yards, at 30 cents per yard	$2,759 10
For banking up the east side, 2,321 cubic yards, at 20 cents per yard	464 20
For building the wall, 2,239.61 cubic yards, at $5 per yard	11,198 05
For 7 stone piles, at $22 apiece	154 00
For coping the wall, 1,705 feet long, 378.888 cubic yards, at $10 per yard	3,788 88
For riprap on east bank, 378.88 cubic yards, at $2 per yard	757 76
For paving west bank and on east bank, where the wall does not reach to 5 feet below low water, 2,416 square yards, at $3 per yard	7,248 00
Total	26,369 99

If, instead of paving the west side, the slope be cut down to 2 to 1, the cost will be less by $6,358, making a total of $20,010 99.

The time required for this work will be about five months, and the engineering expenses as follows:

Salary, $150 per month	$750 00
Office-rent, $12 per month	60 00

Man and boat, $75 per month	$375 00
Extra man occasionally, at $2 per day	100 00
Engineer's instruments	250 00
Additional expenses	100 00
Total	1,635 00

The entire summation is, therefore, as follows:

For breakwater, &c	$924 83
For removing obstructions	500 00
For canal improvements	26,369 99
For engineering expenses	1,635 00
Total	29,429 82

But if the west side of the canal be cut down to the slope of 2 to 1, instead of paving, the total expense will be reduced to $23,071 82.

I add a diagram illustrating the proposed improvement of the canal.

The good to be accomplished by these improvements, and recommending them to the favorable consideration of Congress, is as follows:

The repairs at the breakwater are needed for the further protection of the point, at a place where the old wall has fallen down and is no longer able to prevent the water overflowing.

The cedar posts will prevent the bank being cut away by the undertow, and serve in a measure to build up the point, by arresting sand drifted by the wind.

The advantages gained by removal of obstructions to navigation are sufficiently obvious to speak for themselves.

The canal was constructed to shorten by about six miles the passage in and out of the harbor, and to facilitate regular trips to New York City. At present it is too shallow, except at very high water, for large-sized vessels; and in taking the passage around, the high tide is lost, so that they are often obliged to wait in the harbor for a rise. The canal thus improved would be available when, on account of opposing winds, it is impossible to beat around by the narrow and circuitous channel around Dry Reef. The amount of commerce to be benefited by these several improvements is, as nearly as I could find out, about 25,000 tons per annum. This commerce consists of coal, lumber, farmers' produce, and considerable quantities of shipping stores, and general miscellaneous freight. A railroad is projected, and preliminary surveys have been made to connect Westport with the Shepaug Valley Railroad, at Newtown. This will open a large area in the western part of Connecticut, for which Westport Harbor is the natural outlet, and will, it is thought, considerably increase the commerce.

If the interests of the place are sufficient to warrant any improvement to the navigation facilities, no plan more economical than the one proposed would, in my opinion, be permanent and satisfactory when completed.

I am, general, very respectfully, yours,

H. M. BABCOCK,
Civil Engineer, in charge of improvements of Westport Harbor, (1870.)

Major General G. K. WARREN,
Corps of Engineers, U. S. A.

T 18.

SURVEY AND IMPROVEMENT OF PORT JEFFERSON HARBOR, LONG ISLAND, NEW YORK.

My report upon this survey was made January 14, 1871, and printed with H. Ex. Doc. No. 60, third session Forty-first Congress. The appropriation of $15,000 was made for improving it. The improvement under this appropriation will consist of a riprap sea-wall on the east side of the entrance, to arrest the action of the waves in their movement of gravel and boulders across the channel, and then dredging will be commenced after the sea-wall has become effective.

The following is an abstract of the proposals received for doing the work, in answer to advertisements duly made:

Abstract of proposals for improving Port Jefferson Harbor, Long Island, New York. Received at the engineer office United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and addresses of bidders.	Granite deposited in jettee, per ton.	Excavating per specifications, per cubic yd.	Commence.	Complete.
C. C. Campbell, 104 and 106 John street, New York[*]	$2 83	....	July 1, 1871	Jan. 1, 1872
Thomas G. Cochrane, Astoria, Long Island, N. Y.[†]	3 87½	....	(‡)	(§)
D. V. Howell, 141 Chambers street, New York	4 85	....	Aug. 1, 1871	Dec. 1, 1871
Francis H. Smith, 121 and 123 Front street, New York	4 89	....	....	....
W. H. Beard, 41 Wyckoff street, Brooklyn, N. Y.	....	$0 45	Sept. 1, 1871	(‖)
G. H. Ferris, Brooklyn, N. Y.	....	54½	Sept. 15, 1871	May 1, 1872
Emory R. Seward, Albany, N. Y.	....	1 00	Sept. 1, 1871	June 1, 1872
Dawson, Tank & Co., New London, Conn.[¶]	[**]2 75	....	July 15, 1871	Jan. 1, 1872

[*] Bid informal, not in duplicate, and not accompanied by guarantee or copies of specifications.

[†] Bid informal, the guarantee not made out in proper form, and no certificate that the guarantors are responsible parties.

[‡] One month after date of award.

[§] As soon as practicable thereafter.

[‖] In 90 days, weather permitting.

[¶] Not considered, it having been received at 9.50 a. m., Wednesday, June 7, 1871.

[**] Per ton of 2,240 pounds.

I certify that the above abstract is correct.

G. K. WARREN,
Major of Engineers.

The contract for the sea-wall was awarded to C. C. Campbell, of New York, and for dredging, to W. H. Beard, of Brooklyn, New York.

A thorough survey of the entrance has been made this summer, but as yet no work has been done under the contract.

Port Jefferson is a port for registry, but not of entry. It is, I believe, in the New York collection district.

A good entrance to this harbor will cost not less than $175,000, and I would recommend a liberal appropriation for the continuation of the work, say $50,000.

The following is the original report in relation to this harbor, made by me last winter:

T 19.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 16, 1871.

GENERAL: I have the honor to submit the following report in relation to the survey of Port Jefferson Harbor, which you directed me to make the 21st of July last, in accordance with the requirements of section 2 of the act making appropriations for the improvement of the rivers and harbors, approved June 11, 1870.

I first procured from the United States Coast Survey Office a copy of the map made in 1838, and from you the map of the survey made by Lieutenant Massillon Harrison, United States Engineer, in 1853. The report of this latter survey is printed with the documents accompanying the President's annual message to Congress in 1853.

A comparison of these maps showed that the main harbor or bay was essentially the same in 1838 and in 1853, but that considerable change had taken place at the entrance. The spit on the east side of the channel had advanced westward about 150 yards, and the report of Lieutenant Harrison says a new passage inside of the spit was forming, which the people interested in the harbor were trying to stop, for fear that it would be worse for them.

I was directed by you to visit the place, but I was unable, on account of other duties, to do so until late in the season. I found that the same operation shown to have been going on between 1838 and 1853 had been going on since. The spit on the east side of the entrance had grown some hundred feet longer, and the new channel, which Lieutenant Harrison had reported as forming in 1853, inside the spit, had been completed by nature, giving the same depth the old channel did, and the old channel had filled up till there was but little water in it at low tide.

I found that, in order to locate exactly the works of improvement required, a new survey of the entrance to the harbor would be needed, and that that could only be done to advantage when the means were available to go to work, but that, for all purposes of a report to Congress concerning the requirements of the case, I could get along without it.

I have, therefore, reduced the map of Lieutenant Harrison's survey to a scale of 1 to 10,000, and made such additions to it as I thought necessary to give a clear idea of the harbor. I send that map with the report. I also send a copy of the United States Coast Survey map of the survey of 1838, furnished me by Mr. J. E. Hilgard.

This harbor presents phases of peculiar interest to an engineer. The entrance at low water is not over 600 feet wide and 3 feet deep, and at high water about 1,200 feet wide, with an average depth of 6 feet, and yet it is the only outlet for Port Jefferson Harbor, which has an area of one and one-half square miles, and of two other contiguous bays of an area of about one mile. The mean rise and fall of spring tides is about 9 feet, so that at these tides 1,167,255,000 cubic feet of water passes out and in this entrance at every change of tide. The mean area of section we may roughly take at 6,300 square feet, which would require an average mean velocity of 9 feet per second out and in this entrance. It must be much swifter than the average at some period of the tide. I did not have a chance to measure velocities, but the navigators compared the current to that at Hell Gate. Lieutenant Harrison gave no measurement of velocities.

In looking at the map, one sees at once, by the shape of the "spits," that they are formed by the action of water. Why, then, is it that this narrow channel and shallow depth are maintained against such a current? The explanation is very simple, and offers a most hopeful prospect of making Port Jefferson Harbor one of great public utility. To the eastward of the entrance is Mount Misery Point. It is composed of modified drift, in which are all sizes of drift material, including a few large rounded boulders and a considerable per cent. of small boulders such as are used for cobble-stone pavement. The waves are eroding this point continually, and, while the finer material is washed away, the larger boulders are left along the shore. In heavy storms the big waves strike these stones and roll them along westward, and they fall into the entrance to the harbor. There they accumulate, and the bottom of the entrance is like a boulder-paved street. Even the beach is composed of large gravel-stones, and large quantities of it are transported to New York for use in concrete. In fact, the taking of this material is a thing that will have to be hereafter looked to, as there is danger of making another opening through the Setauket beach, west of the entrance to Port Jefferson Harbor, which would diminish the action of the current at the present entrance, and this should be prevented.

I have seen the action of the waves in driving stones along the shore at other places, but have never before seen so remarkable a result as this harbor presents. One cannot but be struck, in examining the United States Coast Survey map of Long Island Sound, to observe the difference between Port Jefferson Harbor and Huntington Bay, west of it. There it is an open entrance; here, at Port Jefferson, it is all choked up. The action of the waves on Mount Misery Point is the cause of the difference. The remedy is obvious: build out a wall on the east side of the entrance to stop the waves from rolling the stone along the shore westward, and dredge out the material that now obstructs the entrance. I believe this will make a cheap, permanent improvement, and I see no reason why a depth of 14 feet at mean low water cannot be attained and kept if it is authorized. At present I confine my estimates to a depth of 7 feet at mean low water. They will all be found at the end of this report.

I come next to speak of the public importance of this improvement. There are several thousand people living on the bays that have the common entrance. The principal business is ship-building; their vessels are celebrated for their good qualities, and they build as large vessels as can be floated out of the harbor. The builders here have been called upon to model and design vessels that had to be built elsewhere, because their size was too great to get out when built.

The land-locked character of the harbor, and its ample size, make it an excellent place for repairing vessels. Such a one is always of much importance on the route of so many coasters as are bound to and from the great city of New York, at which latter place the value of water-front is too great to furnish space for ship-yards and mooring-places for coast-vessels undergoing or awaiting repairs. On account of the number of vessels built here, the place is made a port of registry, but not of entry. An improvement of the entrance, so that 7 feet could always be kept up, would greatly increase the importance of the place, by allowing a line of steamboats to be run regularly to New York, without regard to tide, which they cannot now do. The place will probably soon have a direct railroad to New York. At present it is about eleven miles from the railroad.

Port Jefferson is in the third light-house district. The nearest light-house is at Old Field Point, two miles west. The light-ship at the Middle Ground is about six miles north of it. The harbor has an area of about one and one-quarter miles, in which the depth is from 18 to 24 feet mean low water, and completely land-locked. Vessels drawing over 3 feet cannot enter at ordinary low water. The average rise of the tide is 7 feet, and of spring-tides 8½.

As a harbor of refuge for coasters it is an excellent situation, and would be of inestimable value. This question is one of very great public importance, and, in order to properly appreciate any special harbor like this, its relation to others should be pointed out, and the general system displayed to which it relates or forms an essential part.

I have ascertained that there has not been any system of harbors of refuge devised for Long Island Sound, and although it is too great a subject for me to comprehend fully in so short a time, yet, as there must be some general idea presented, in order to value properly this special case, I will say something on the general question.

The great gales, which occasionally overpower the best efforts of the seamen in Long Island Sound, are either from the northwest, northeast, or southeast. The general course of the sound being east and west, it thus happens that in these cases vessels bound both ways cannot all keep on their course. Those the winds do not favor, that are deeply laden, or crippled, must run with a free wind for some shelter.

What are the harbors on Long Island Sound from New London to New York, a distance of one hundred and twenty miles?

On the north shore we have New Haven, fifty-five miles west from New London; a good harbor, a little out of the course of vessels, and requiring improvement. Next comes Black Rock Harbor, twenty-two miles distant east from New Haven, and very insufficient; and then there is no other on that side the sound, though they are needed.

On the south side of the sound there is no want of good harbors between New York and Huntington Bay, a distance of forty-five miles. Thence eastward there is no other harbor on the south side of the sound.

To open Port Jefferson to coasters would diminish the unprovided space twenty-five miles. It would then become, as far as I can see, a terminal harbor of refuge against easterly winds for all coasters going eastward from New York. Its large capacity peculiarly fits it for such a condition. This harbor would also, if available, be eagerly sought by westward-bound coasters in distress, for many vessels are annually wrecked in the neighborhood for want of shelter.

I will not here attempt to amplify this subject further, because I could only do so by entering into minor details, upon which I am not prepared.

The subject of harbors of refuge for coasters is one worthy of the most careful considerations of Congress, in view of the risk to life and business involved. The nation spends considerable money to protect the lives and business of our traders in foreign lands, and its benefits are admitted. As a mere protection to life and property these coast harbors of refuge have a strong public claim. Congress has supreme control over all questions affecting navigation, and should act in that spirit; and as everybody else is prohibited from doing anything by the Government, the Government should do what is needed. It is under a solemn obligation to the people to do it. The effect of convenient harbors of refuge is to embolden navigators. Confidence in ability to find shelter enables freighters to load their vessels deeper, gives opportunity to vessels of less seaworthy qualities to navigate the waters, and allows the vessels that belong to rivers whose depth is not great enough to allow of a draught necessary for sea-going qualities to venture upon the open waters. The capacity of all coast vessels now built is increased, and others are allowed to mingle in it that now cannot venture. Thus the profitable employment of vessels is increased, without increasing at all the capital invested in the vessels themselves. Cheaper freights result, business becomes prosperous where before it languished, and ultimately the works become a source of profit to the Government.

I annex a communication from H. W. Swezey, deputy collector, (marked A,) giving a detailed statement of the business carried on at Port Jefferson. It is in the collection district of Sag Harbor. The nearest port of entry is Bridgeport, Connecticut, at which the revenue collected during the fiscal year ending June 30, 1870, was $12,164 40.

Estimates for the improvement required at Port Jefferson Harbor.

These are to build a breakwater, and dredge out the entrance.

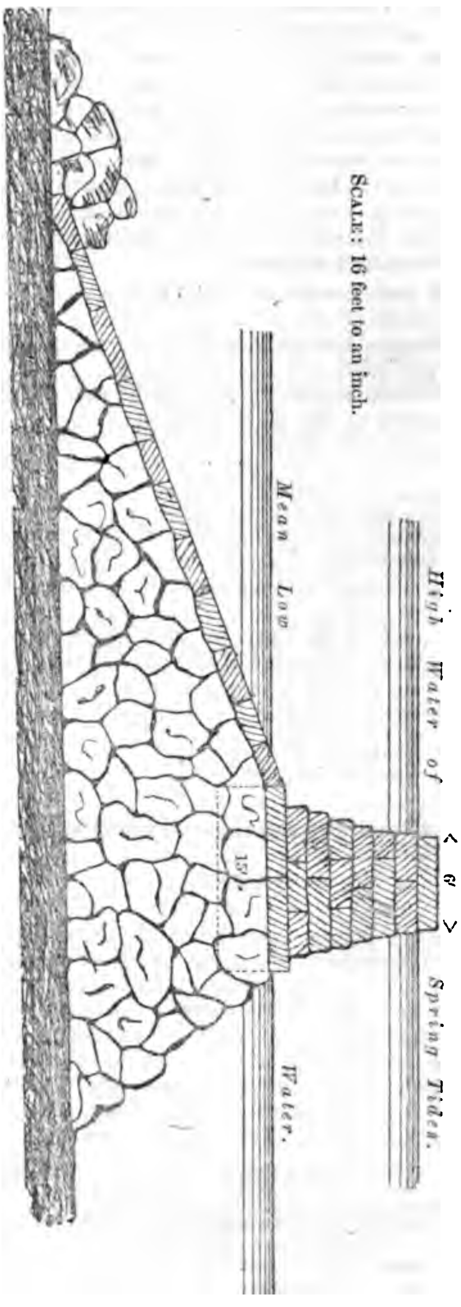
The breakwater must be built from the highest water-line on the beach northward into the sound. Its object is to arrest the sand, gravel, and boulders moving westward under the action of the waves. I provisionally locate it at 250 yards east of the entrance, because it will be shorter to build than if nearer the entrance, and because this leaves space for drift material, if it should accumulate at its extremity, to do so for a long time without reaching the channel. I believe, however, that the current in and out of the harbor will be quite sufficient to sweep away all the material that escapes around the breakwater, and that this latter will be sure to arrest all the large gravel-stones and boulders, such as at present choke up the entrance.

The breakwater I estimate for on the following plan:

Section of breakwater.—Spring tides rise 9 feet above mean low water. The top of the wall to rise 2 feet above high water of spring tide.

Wall to be 6 feet wide on top; batter 4 upon 1, down to 1½ feet above low water; to be composed of granite blocks of from 2 to 4 cubic yards each, of a thickness from 18 inches to 2 feet; to be doweled throughout with gun metal dowels, and top course securely clamped with wrought iron of suitable size, (cost, say $25 per yard.)

This wall to rest on a bed formed by throwing in large irregular blocks of stone, of not less than 1¼ tons weight, having a slope seaward of 1 upon 3, and shoreward of 1 upon 1, and to be 15 feet wide on top, at level of mean low water. This foundation to be brought to even surface by small angular stone, and paved on the sea-slope with large granite blocks 1½ feet thick and not less than 2 tons weight, clamped with wrought iron. The foot of the paved slope to be protected by large riprap stone, same as for the body of the breakwater, to contain about 4 cubic yards per linear yard of breakwater. All the riprap to cost, say, $6 per yard; the pavement, $25 per yard. The above wall is proportioned so as to be about the same cost as a rough breakwater would be made of the same height, namely, 11 feet. As the height in-



creases, there is a great saving in combining them as I have. This particular form is adopted as the basis of calculation. It may be modified in practice as may be necessary. The body of the work may not need paving. From the experience with the sea-wall at Southport, the thickness of wall adopted will be sufficient to stand the waves of Long Island Sound. The Southport sea-wall is 9 feet above ordinary low water, and it is thought that 2 feet additional height should be given to it. This is the reason a height of 11 feet is taken above mean low water for this design. The waves in heavy storms and high tides will break over such walls, but not enough to cause any swell, and if the wall be well built, it will probably stand the shock. However this wall may answer, it is probable that a lighter structure of stone should not be adopted.

My complete plan is to build the breakwater out to the 9-foot curve, a length of 800 feet:

To build body of breakwater, 6,833 cubic yards, at $6 per yard	$41,000
To pave the outside slope if needed, 990 cubic yards, at $25 per yard	24,750
To build top wall, 11¼ yards, per linear yard, 300 yards long, 3,375 yards, at $25 per yard	84,375
	150,125

For dredging a channel 100 feet wide, and 7 feet deep at mean low water	$7,500
For dredging the same, 200 feet wide, and 7 feet deep at mean low water	15,000
A part of the breakwater beginning at the shore should be the first thing built, from highest water mark out 100 feet beyond low water mark, say	20,000
For dredging the 100-foot wide channel, 7 feet deep	7,500
Total	27,500

I therefore recommend an appropriation of $27,000 for Port Jefferson Harbor.

Yours, respectfully,

G. K. WARREN,
Major of Engineers, Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

A.

PORT JEFFERSON, *January* 14, 1871.

SIR: I have the honor to lay before you a brief statement of the commercial and marine importance of the port of Port Jefferson, New York. You will please find it on the sheet accompanying this.

I am, sir, yours, respectfully,

H. W. SWEZER.

General G. K. WARREN, U. S. A.,
Newport, Rhode Island.

Port of Port Jefferson, District of New York.

	Tons.	Tons.	No. of vessels.
January 1, 1871, registered and enrolled tonnage, outstanding at Port Jefferson, New York, over 20 tons		12,902.68	158
January 1, 1871, licensed tonnage, outstanding at Port Jefferson, New York, under 20 tons		1,105.96	106
Total		14,008.64	264
Number of vessels built at Port Jefferson in the year 1870, 14, tonnage	3,614.77		
Number of vessels built at Port Jefferson in the year 1869, 7, tonnage	2,012.16		
Increase for 1870	1,602.61		
Outstanding tonnage at Port Jefferson, January 1, 1870, registered, licensed, and enrolled vessels, tons		11,654.24	238
Increase for 1870, tons		2,354.40	26

From one half to three-quarters of the above tonnage is owned at Port Jefferson.

There was, during the year 1869 and 1870, 16,000 barrels of flour exported from here.

There are eight sets of ways for the purpose of hauling out and repairing vessels, which are almost constantly occupied, which afford employment for a great many mechanics, and are very beneficial to the place. We have a large carriage factory, which is sending its manufactures into the far West and other places of the United States.

Port Jefferson contains about 2,500 inhabitants; is the most important place on the north side of Suffolk County, There are two railroads projected to have termini here. The back country is being cleared up rapidly and settled, and, with the entrance to its harbor deepened and protected, it will be the most important harbor on the north side of Long Island.

Respectfully, yours,

H. W. SWEZER,
Deputy Surveyor.

General G. K. WARREN, U. S. A.,
Newport, Rhode Island.

T 20.

SURVEY AND IMPROVEMENT OF PECONIC RIVER, LONG ISLAND, NEW YORK.

The survey of this river was authorized by section 2 of the act approved July 11, 1870, and was made and reported by me January 23, 1871, and printed as part of H. Ex. Doc. No. 60, third session, Forty-first Congress. The amount required to make a channel up to Riverhead 75 feet wide and 6 feet deep at mean low water was $32,818 50, and the amount appropriated by the act approved March 3, 1871, was $5,000.

In order to get some immediate benefit from this appropriation it was determined to employ a dredging-machine of the Osgood pattern to dig a channel-way as wide as she could by emptying the material from the bucket alongside, and not to employ dumping-scows, which, on account of the very shoal water, could only be moved when loaded at time of high tide. By this plan a great deal more ground could be gone over than in the ordinary way. It is a very unsatisfactory way of working, but considered best under the circumstances. Further appropriation should be made to widen the cut now being made by the employment of scows to take away the excavated material.

Advertisement was duly made for proposals to furnish a dredge and work her by the hour or day. The following is an abstract of the bids received:

Abstract of proposals for improving the Peconic River, Long Island, New York. Received at the Engineer Office, United States Army, Newport, Rhode Island, Wednesday, June 7, 1871.

Names and addresses of bidders.	Price per hour for use of dredge.	No. of cubic yards per hour the machine is guaranteed to excavate.	Width of cut machine can make, dumping material along shore.	Commence.
Morris F. Brainard, Albany, N. Y.	$8 75	50	26 feet	July 10, 1871
H. C. Douglass & Co., Windsor Locks, Hartford County, Conn*	6 00	30	(†)	July 1, 1871
E. G. Brown, Elizabethport, Union County, N. J.	(‡)	(§)		‖July 15, 1871

* Bid informal, it not being in duplicate, and not accompanied by copies of specifications.
† The width of cut must depend upon the depth of water to be made, say, probably, fifty feet.
‡ $100 per day, ten hours to constitute a day's work.
§ One of Osgood's best machines; number of cubic yards per hour not stated.
‖ Or whenever engineer wants.

I certify that the above abstract is correct.

G. K. WARREN, *Major of Engineers.*

The contract was awarded to Mr. M. F. Brainard, of Albany, New York.

His dredge has been at work during most of August, and the work is progressing as favorably as could be expected.

I would recommend an appropriation to complete the work as first designed. The amount required is $28,000.

The Peconic River is in the Sag Harbor collection district, and that place is the nearest port of entry. The revenue collected there during the fiscal year ending June 30, 1871, was $1,103 90.

I annex to this my report made last January, to which some additions have been made:

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 23, 1871.

GENERAL: I have the honor to submit the following report, with map of the survey of the Peconic River, Long Island, below Riverhead, authorized by section 2 of the act making appropriation for rivers and harbors, approved July 11, 1870.

This map is on a scale of an inch to 200 feet, and was made, as well as the survey, by Mr. Nathaniel E. Russell, civil engineer, assisted by Mr. L. S. Chase.

The report of the survey, also made by Mr. Russell, I submit herewith as a part of my own report. It gives a description of the river, a statement of the wants of the locality, a history of what has been attempted heretofore by private parties, the importance of the work, and how to do it, and an estimate of the cost of opening the required channel so as to make it 75 feet wide and 6 feet deep at mean low water.

The money required to make the desired channel up as high as Terry & Wells's dock is $32,818 50, and I recommend that the improvement be not carried further than that place.

As the tide rises and falls, on an average, about 3 feet, there will be, at high tide, a depth of about 9 feet up to Riverhead after the channel is improved.

Riverhead is in the collection district of Sag Harbor, which is the nearest port of entry. The amount of revenue collected there in the fiscal year ending June 30, 1870, was $2,425 17.

It is in the third light-house district. The nearest light-house on the line of water communication is on Plum Island.

I send with this the map of the United States Coast Survey made in 1838. Scale, 1 to 10,000—a tracing.

Respectfully submitted.

G. K. WARREN,
Major Engineers and Brevet Major General.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army.

Record of tide observations at Terry & Wells's wharf, Riverhead, Long Island, New York.

Date.	A. M.												M.	P. M.													
	6.	6.30	7.	7.30	8.	8.30	9.	9.30	10.	10.30	11.	11.30	12.	12.30	1.	1.30	2.	2.30	3.	3.30	4.	4.30	5.	5.30	6.	6.30
1870.	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*
November 26	....	......	1.5	1.4	1.2	1.0	8.5	8.0	9.5	1.1	1.6	2.0	2.4	2.8	3.2	3.6	3.8	3.85	3.75	3.4	3.1	2.8	2.55	....	....	....
November 28	....	......	1.6	1.45	1.3	1.2	1.2	1.1	1.05	0.9	1.0	1.0	1.0	1.0	1.3	1.6	2.1	2.5	2.9	3.1	3.2	*3.25	....	....	....	....
November 29	....	......	2.6	2.4	2.2	2.0	1.8	1.6	1.5	1.4	1.25	1.2	1.2	1.0	1.0	1.1	1.4	1.7	2.1	2.55	2.9	3.15	3.3	3.5	....	....
November 30.	....	......	3.0	3.0	2.9	2.7	2.4	2.1	2.0	1.8	1.6	1.45	1.35	1.25	1.1	1.1	1.07	1.2	1.4	1.8	2.3	2.55	2.85	3.1	3.27	3.3
December 1.	....	......	3.1	3.05	2.9	2.7	2.65	2.25	2.0	1.8	1.6	1.4	1.3	1.2	1.1	1.0	0.7	0.5	0.4	0.3	0.3	0.45	0.7	....	....	....
December 2..	....	......	2.1	2.5	2.7	2.7	2.65	2.7	2.5	2.2	2.0	1.75	1.5	1.4	1.3	1.15	0.93	1.0	1.0	0.95	0.92	0.95	1.0	....	....	....
December 3..	....	......	2.55	2.85	3.1	3.3	3.4	3.25	3.0	2.8	2.5	2.28	2.0	1.8	1.6	1.4	1.2	1.0	0.9	0.78	1.0	0.85	*0.75	....	....	....
December 5..	....	......	2.3	2.65	3.05	3.4	3.7	3.95	4.1	4.15	4.4	4.25	3.95	3.6	3.3	3.05	2.8	2.58	2.35	2.15	2.0	1.8	1.6	....	1.78	....
December 6..	....	......	2.9	3.1	3.4	3.7	4.0	4.3	4.6	4.6	4.6	4.3	3.95	3.6	3.2	2.85	2.6	2.4	2.2	1.95	1.75	1.55	1.4	....	1.0	....
December 7..	*0.7	0.85	0.9	1.2	1.58	1.9	2.3	2.7	3.0	3.4	3.6	3.8	3.8	3.5	3.3	3.0	2.7	2.5	2.2	2.0	1.7	1.48	1.3	....	....	....
December 8..	....	......	1.9	2.2	2.5	2.75	3.15	3.45	3.65	3.9	4.2	4.35	4.3	4.28	4.3	4.0	3.6	3.2	2.9	2.6	2.3	2.1	1.8	....	....	....
December 9..	....	......	0.9	0.9	0.7	0.9	1.0	1.3	1.75	2.28	2.68	3.05	3.2	3.3	3.4	3.3	3.15	2.9	2.65	2.4	2.15	1.9	1.7	....	....	....

* 3, 5—Those marked thus, were interpolated.

These observations were selected from the whole number as being the best and the least modified by winds. Mean low water, from these, is 0.94 on the gauge; mean high water, 3.65; giving the mean rise and fall, 2.68 feet.

The bottom of the sill of the west side of Terry & Wells's lumber shed is 5.8 feet above mean low water.

The following are the names, capacity, and draught of the vessels running on the Peconic River, Long Island, New York.

Names.	Tons.	Draught.	Names.	Tons.	Draught.
		Feet.			*Feet.*
Schooner D. B. Pills	200	8	Schooner Mary E. Woodhull	230	9
J. S. Herneus	80	5½	Sloop Palmsley	60	6
Myrtle	100	8	Phantom	50	5
Adda Hallock	75	6	Pauline	80	8
Anada	100	7	Patriot	60	6½
Jenny Lind	130	7	Peerless	40	6
Sloop Enterprise	75	7	Young America	16	4
J. Adams	75	6	General Jackson	15	4
Diligent	75	7	Riverhead	18	4½
Nearchus	80	7	Dexter	17	4½
Sarah F. Jane	40	5	L. Terry	30	5
Benjamin	45	5	Minnie Warren	18	4
D. F. Vail	45	5½	William Downs	30	5
Petrel	25	5½	Yankee	20	4
H. Planter	40	5	Would if you could	15	4
Dauntless	35	6	Adelia	15	3
Mary E	35	6	Schooner Anida	95	8
Bonita	40	7	Price		
Cora L. Griffin	20	4	Sloop Richard D. Benjamin	20	4
Mary Jane	20	5	Sirocco	40	5
Hellen	20	4	Simoon	30	4
Lilly	20	4	U. S. Grant	25	4½
John S. Marcy	25	4	Pelican	20	4
Waterwitch	40	5	Black Bird	15	5
Antelope	50	5½	Hatfield	30	6
Fox	40	5	Clyde	20	5
President	65	7			

T 21.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 23, 1871.

GENERAL: I have the honor to submit the following report, with map of the "survey of the Peconic River, Long Island, below Riverhead," authorized by section 2 of the act making appropriations for rivers and harbors, approved July 11, 1870.

This map is on a scale of an inch to 200 feet, and was made, as well as the survey, by Mr. Nathaniel E. Russell, civil engineer, assisted by Mr. L. S. Chase. The report of the survey, also made by Mr. Russell, I submit herewith as a part of my own report.

It gives a description of the river, a statement of the wants of the locality, a history of what has been attempted heretofore by private parties, the importance of the work and how to do it, and an estimate of the cost of opening the required channel so as to make it 75 feet wide and 6 feet deep at mean low water.

The money required to make the desired channel up as high as Terry & Wells's dock is $32,818 50, and I recommend that the improvement be not carried further than that place.

As the tide rises and falls, on an average, about 3 feet, there will be at high tide a depth of about 9 feet up to Riverhead after the channel is improved.

Riverhead is in the collection district of Sag Harbor, which is the nearest port of entry. The amount of revenue collected there in the fiscal year ending June 30, 1870, was $2,425 17.

It is in the third light-house district. The nearest light-house on the ne of water communications is on Plum Island. I send with this the map of the United States Coast Survey made in 1838. Scale, 1 to 10,000—a tracing.

Respectfully submitted.

G. K. WARREN,
Major of Engineers, Brevet Major General.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 20, 1871.

GENERAL: In pursuance of instructions from you, dated November 1, 1870, the party under my charge, consisting of Mr. L. S. Chase, as assistant, and three men, proceeded to Riverhead, Long Island, to ascertain the nature and extent of obstructions in Peconic River, and to make a survey of the locality needing improvement.

Riverhead is the county seat of Suffolk County, New York, and has between twelve and fifteen hundred inhabitants. It is connected with New York by the Long Island Railroad, being seventy-four miles distant, and owing to its favorable situation with respect to the surrounding country is the center of considerable trade.

The trade is, in a great measure, influenced by Peconic River, on which it is situated, and as this is now so shallow as to admit the passage, at high tide, of no vessels drawing more than 4 feet of water, the people of the district are desirous of having its channel opened from the town to its mouth, (two and three-quarter-miles below.)

It was ascertained from the leading men of that place that they desired this channel to be 75 feet wide and 6 feet deep at low water, and a paper setting forth the reasons which they think would justify the United States Government in making an appropriation to do this work I transmit to you with this report.

This paper, accompanied by a list of vessels trading on the river, contained numerous signatures, and was an expression of the general sentiment of the town and country.

Trade on Peconic River is, at present, carried on by means of scows to a great extent; vessels, from various parts of the country, bringing cargoes of merchandise are compelled to anchor below Indian Island, at the mouth of the river, about three miles from the town, and there discharge subject to various losses from delays or weather; and, from such statements and figures as could be had, the cost of transportation by water is, from this circumstance, increased about 30 per cent. above what it would be if such vessels could be brought up to the docks at Riverhead. The cargoes, at present, are principally lumber, coal, and wood, the latter being shipped to various places, besides general merchandise; and as the former are among the most extensive branches of trade in this section of Long Island, its interests are very much concerned in any step tending to their encouragement.

The improvement of Peconic River is not a new idea. Many years ago a stock company was chartered by the State of New York, which had this object in view. The plan proposed was to construct dams at various places on the stream above the town of Riverhead, and, by means of canals and locks, to communicate with the deep water below; but, for some reason, no steps were taken to carry on the work, and the charter was annulled, after having remained in force for a specified time.

Since this failure, an attempt at dredging has been made, traces of which are still visible. The channel below Colonel's Island, for some distance, was deepened to about 4 feet at low water, with dredging machinery run by horse-power.

The material excavated was deposited immediately beside the trench dug, and still forms what is known as "the Mud-Digger Bank," shown at X, Y, Z, on the map accompanying this report. This work was done about thirty years ago, and, although it seems to have altered the river immediately above Colonel's Island somewhat, has itself remained unchanged, and argues the permanence of similar works in the future. The change referred to was merely the growth of the small island seen at A, on the map, and a slight filling of the channel on the north side of Colonel's Island, which would naturally result from turning the main current of the river toward the right, after passing Hoyle's dock.

The general surface of the country near the headwaters of Peconic Bay is very flat, so much so that a person standing on the shore of the sound at Prospect Hill, nearly due north from Riverhead, can see clear across the island to the light-houses on the south side, some twenty-two miles distant.

The soil is almost exclusively sand, covered, to a great extent, by wood farms, principally pine, maturing once in every forty years, on an average. There is some oak and hickory. The agricultural products are very various, and the inhabitans are much in need of cheap fertilizers, which can only be had by water, because of the expense of transporting them by railroad.

On the southern shore of the island, about twelve miles from Riverhead, magnetic iron ore, in the form of sand, is found in great abundance, and some iron and steel have already been manufactured; but it has been found that this material cannot be worked with profit on a large scale.

The position of Peconic Bay and River, running nearly in the center of the island, makes Riverhead a natural center from which to communicate with the surrounding country. Above the town the river is quite small and insignificant; but here it has been dammed, and its water is used for manufacturing purposes, principally wood-working. After passing below this to the point where the bridge crosses, it is scarcely 50 feet wide, gradually spreading out as it goes, until, at the mouth, it is nearly half a mile across.

The banks on both sides are, as a rule, swampy, with occasionally a stretch of sand. The surface of these swamps, or wet meadows, is composed of rank weeds, whose roots, growing together from year to year, form an elastic covering for the material underneath, which is very soft mud. In many places a person passing over this upper coating can see and feel its vibrations for some distance around him, and in a few instances it is dangerous to venture across. By a removal of the covering it was found that an 8-foot pole could be pushed into the mud, with great ease, for its whole length, and I was informed that a depth of 17 feet had been reached without finding bottom.

The spot C in Merritt's Bay, on map, is a bottom of this kind in the river, and vessels drawing nearly 5 feet are anchored there at all times, rising and falling with the water, and at low tide having a depth of flotation within a very few inches of that at high tide. The nature of the bottom generally, however, is quite different, being much more compact. At the town, where the average depth at low water is 1 foot, the bottom is fine sand, and as it passes from Terry & Wells's dock to Merritt's Bay, gradually becomes mud, the channel passing along the south side of the bay. Below this the channel deepens until, at Hoyle's dock, it contains 3 feet of water.

Immediately below this is a small bed of gravel, and between this and Colonel's Island the channel again becomes shallow until the island is reached. It then deepens again, and at the southeast end forms a pool of five feet water.

Below there is a 4-foot channel-way, becoming 5 feet deep at F, and at Indian Island becoming nearly 6 feet at mean low water. Between Indian Island and Jamesport, five miles below Riverhead, there is a good 6-foot channel at mean low water.

Tide-gauges were established at Riverhead, Jamesport, and a place between the two, but after careful comparison of all three, it was apparent that the difference of rise and fall in the tide was too small for practical consideration. The low-water mark was therefore established from the gauge at Riverhead, as being more accessible than either of the other places.

The mean rise and fall of the tide, estimated from a series of twenty-four observations, was 2.65 feet, and the low-water mark, as shown in the note-book, was 5.8 feet below the sill of Terry & Wells's lumber-shed. This being the most permanent bench that could be secured under the circumstances, was very accurately sketched by Mr. William Hummerstown, and from it any one could again work, should necessity ever arise.

The survey of the river was begun on the 23d of November, and conducted upon the usual principles. Base-lines were measured on both sides of the river, and connected at the bridge in Riverhead. The other end, as well as most of the intermediate stations, were located by triangulation, as was the high-water mark. The soundings were taken at the rate of four each minute, two of which were located, and the remaining two being considered as intermediate.

All but the six last lines of soundings extended from shore to shore, but these taken on the 19th day of December, 1870, could not be made to correspond, on account of ice, which was blocked against the shore from station 31 to 34.—S. B.

Observations on the tide-gauge were taken every half hour, and, at times, every fifteen minutes.

The islands in the river were all located by triangulation.

The map was plotted on a scale of $\frac{1}{2400}$, and upon it is marked, in red lines, the position of such a channel as is asked for. The lines indicating this were intended to follow the course of the deepest water, and to accomplish the desired end with the least excavation, subject, of course, to such modifications as might be necessary upon the actual undertaking of the work.

The profile was plotted on a horizontal scale of $\frac{1}{2400}$, and a vertical scale of $\frac{1}{12}$, the soundings used at the end of every hundred feet being plotted as near the average as was possible of all within that distance. I have calculated the amount of material that must be excavated to make such a channel as the business men of Riverhead desire, viz., 75 feet wide and 6 feet deep at mean low water, as stated in the first part of this report. This depth of 6 feet is adopted because that is the depth, at mean low water, on the bar at the entrance just above Jamesport.

The shallow nature of the river above Colonel's Island will require a dredge-boat to excavate a channel for the scows to float in alongside of her, and it may be best to make the first cut of 25 feet width, by dropping the material from the buckets on the bed of the river on one side or the other, as may be most advantageous. The work of the dredge may then proceed in the usual way, with scows alongside.

These scows can only be dumped at all times of the tide by being carried below Indian Island, an average distance of one and one-half miles. At high water the material can, in many cases, be dumped on flats adjacent. The material is such as can be best excavated by a Morris & Cumming's dredge.

It is evident that this channel-way, if made at all, should extend as far as the village of Riverhead, but it is questionable whether it should go beyond the first dock shown on the map—Terry & Wells's. The ground along the north bank of the river, between this dock and Merritt's Bay, would afford sufficient docking for the use of the village at present; but to meet the desires of some of the residents, estimates have been made to the bridge above separately. These are as follows:

1st. From Indian Island to Terry & Wells's dock, 119,340 cubic yards, at 25 cents	$29,835 00
2d. From Terry & Wells's dock to bridge, 20,800 cubic yards, at 25 cents	5,200 00
3d. From Indian Island to bridge, 140,140 cubic yards, at 25 cents	35,035 00
Engineering expenses, estimated at 10 per cent., would make, when added, a total—	
From Indian Island to Terry & Wells's dock	32,818 50
From Terry & Wells's dock to bridge	5,720 00

Should this improvement be made, the people of eastern and central Long Island would be very much benefited by it.

A better and more convenient harbor for vessels trading in the adjacent waters might be obtained, without extensive improvements, at Jamesport, five miles below Riverhead; but this would not accommodate the same interests as opening the channel of the Peconic. The additional difficulties attending the transportation of articles from the latter place, after their arrival, would somewhat modify any advantages arising from such an improvement.

I am indebted to Mr. James B. Slade, of Riverhead, and to the citizens generally, for valuable assistance while in that village.

Very respectfully,

NATHANIEL E. RUSSELL,
In charge of Survey of Peconic River.

Brevet Major General G. K. WARREN, *U. S. A.*

RIVERHEAD, LONG ISLAND, *January* 21, 1871.

MY DEAR SIR: Multiplicity of business cares has prevented me from writing you sooner, as I should have done. During the interval of your leaving and now, I have hardly seen the time I could attend to it (the collection of statistics) properly. But to the work:

The amount of capital invested in manufacturing and mercantile pursuits in this village is about $500,000. There are twenty stores, four mills in the immediate village and two more within one mile, and thus really of the village, while there are others farther west, but near enough to be affected by the same causes that affect the village. The amount of freight paid the Long Island Railroad at the depot, annually, is about $10,000, and about $15,000 is paid for freights by water, by way of the river. We have some thirty vessels, larger and smaller, drawing from 4 to 7½ feet of water, which are running back and forth during the season. This village is in the shire or county, and hence has something more than mere local importance. It is the center of the county, and commands, to a considerable extent, the trade, and is the market for a large extent of territory. It is no uncommon sight to see from thirty to sixty wagons and carriages of a single day standing or moving about in Main street.

The deepening and widening of the channel of the river will not affect the village only, but the whole county, more or less. I do hope we may receive some assistance. It certainly will be a valuable improvement, and win the hearts of many people. The cost of lighterage to the village now is a clever amount, and the detention, besides, affects the business of the place.

We wish to put our case on the merits, the facts being fairly understood, and then rest, trusting to the good sense of those in whose hands it is committed.

I am, as ever, very truly, yours,

JOSHUA L. WELLS.

N. E. RUSSELL, Esq.

Received January 30, 1871, and respectfully forwarded, to be attached to my report on the survey of the Peconic River, below Riverhead, Long Island.

G. K. WARREN,
Major Engineers, Brevet Major General, U. S. A.

DECEMBER, 1870.

GENERAL: We, the citizens of the town and village of Riverhead, county of Suffolk, and State of New York, do respectfully show that Peconic River, in the aforesaid town and county, is much used for commerce; that, by reason of the almost entire absence of harbors on the eastern end of the island on its northern and southern coasts, the said Peconic River is of much importance in supplying the island on the eastern portion thereof with merchandise, &c., &c.; that its channel is now imperfect in sundry places, and that its use for purposes of commerce involves continuous labor, detention, expense, and risk of property, which we believe might be avoided by the use of a moderate amount of money, judiciously expended in clearing out the channel from Peconic Bay to the docks in the lower part of the village of Riverhead, the county-seat of Suffolk County; and we further believe that a channel of a width of 75 feet, and of a depth of 6 feet at low water, will greatly diminish the losses and expenses to which the business of this river is now subject to. And we further desire to show that, by reason of the said imperfections in the channel, that all vessels drawing over 4 feet are compelled to anchor at Indian Island, an exposed situation in Peconic Bay, and discharge their cargoes into scows, which are pushed up to the docks at Riverhead at a considerable expense, and subject to much detention, in consequence of striking upon various shallow places in the channel, and from other causes; and we believe that the business interests of a considerable portion of the island are affected and retarded by the above-mentioned causes.

Signed by—

TERRY & WELLES.
SAM'L GRIFFIN.
BENJ'N F. HOWELL.
GEO. A. BUCKINGHAM.
HILL BROS.
WM. BAIRD.
FOSTER & ACKERLY.
M. F. BENJAMIN.
J. R. & J. H. PERKINS.
N. S. WOODHULL.
J. M. EDWARDS.
CHAS. L. CORWIN.
JACOB DOW.
JOHN P. TERRY.
N. CORWIN & SONS.
GILBERT CORWIN.
H. CORWIN & SON.
JNO. C. DAVIS.
GEO. W. RAYNOR.
CHAS. HALLETT.
E. T. SQUIER.
SEWELL & SELF.
GEO. HUDSON.
JNO. G. TERRY.
WM. W. HILL.
HUBBARD CORWIN.
JNO. CORWIN.
JA'S B. SLADE.

Brevet Major General G. K. WARREN, U. S. A.

T. 22.

SURVEY AT NARRAGANSETT PIER, RHODE ISLAND.

This survey was made, and map and report completed, on January 23, 1871. The report was printed as part of H. Ex. Doc. No. 60, Forty-first Congress, third session. No further appropriation was made by Congress, and nothing has been done since. I resubmit the report before made.

After the improvement therein recommended has been made, it will be practicable for small steamboats to land there in all ordinary weather, but in order that the landing shall be practicable in time of easterly storms, a sea-wall, extending out some thousand feet or more, will be necessary, and will cost not less than $500,000. In case this is attempted, it would not be desirable to begin the work with an appropriation of less than $60,000.

The nearest port of entry is Newport, Rhode Island, and it is in the Newport collection district. The revenue collected there in the fiscal year ending June 30, 1871, was $3,241 69.

T. 23.

ENGINEER OFFICE UNITED STATES ARMY,
Newport, Rhode Island, January 23, 1871.

GENERAL: I have the honor to submit the following report, with map of the survey of Narragansett Pier, Rhode Island, authorized by section 2 of the act making appropriations for rivers and harbors, approved July 11, 1870.

The map is on a scale of $\frac{1}{1250}$, and was made, as well as the survey, by Captain J. A. Judson, assistant engineer, assisted by Mr. J. H. Dager, civil engineer, and Mr. J. Pierpont, civil engineer. The report of the survey, also made by Captain Judson, I submit herewith as a part of my own report.

The report of the survey gives a description of the place; a statement of the wants of the locality; a history of what has been attempted heretofore by private parties, and the several plans suggested for the creation of a harbor here; the importance of the attainment of this object, the difficulties attending it, and the best mode of overcoming them; together with plan and estimate for the simplest mode of giving a harbor for local purposes. The feasibility of making a harbor of refuge here for general purposes is also discussed, and all other information called for by existing rules and regulations is given.

The money required to make the desired improvement is $12,326 24, and I recommend that the improvement be not carried further than that plan.

Very respectfully,

G. K. WARREN,
Major of Engineers, Bvt. Maj. Gen., U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 21, 1871.

GENERAL: I have the honor to report that, in pursuance of your verbal instructions to me of December 24, 1870, on the 27th of that month I proceeded to organize a party for the survey of Narragansett Pier, Rhode Island, in pursuance of section 2 of the act making appropriation for the survey of rivers and harbors, approved July 11, 1870, and of the orders of the Chief of Engineers to yourself, dated July 21, 1870.

This survey is made with a view to examining into the question of the construction of a breakwater at this point, as a means of providing a harbor artificially where none is afforded naturally.

This place, known as Narragensett Pier, is a village located on the eastern seashore of the western part of the State of Rhode Island, fronting on the Atlantic Ocean five miles northerly from Point Judith. Its geographical position is indicated on the sketch marked A, accompanying this report.

It was anticipated that, with favorable weather, a few days would suffice in which to obtain all the information necessary to satisfactory discussion of the subject; but a succession of stormy days prevented anything being done until the 3d of January, when I dispatched a portion of the party to the pier with the necessary equipment, following myself the next day, with Mr. J. H. Dager, civil engineer, and Mr. J. Pierpont, civil-engineer assistants.

The field-work was continued, as the weather permitted, during a period of seven days, with some few satisfactory results, but, after my report of the 8th instant, was finally abandoned, on the 10th instant, under instructions from you dated January 9, 1871, leaving the survey incomplete, the constantly prevailing heavy seas and high winds rendering reliable work on the water impossible, and on the land slow and difficult. It is unfortunate that the pressure of other duties prevented the accomplishment of this survey earlier in the season, for, exposed as Narragansett Pier is to the full force of the waves of the Atlantic Ocean, it was with extreme difficulty that any hydrographic work could be executed during this inclement season of the year. As it is, the map I have been able to prepare, and which I have the honor to submit herewith, while it gives some useful information perhaps hitherto uncollated, is unsatisfactory, since it is wanting in that most essential to the discussion of the matter in hand, *i. e.*, a full exhibit of the contour of the bottom along the entire frontage of the village. I may mention here, however, that the figures in black, representing soundings in the neighborhood of the upper or north pier, were taken on the only day during the progress of the survey when sounding was at all practicable, and may be considered comparatively reliable. Those given in red are located approximately from the United States Coast Survey chart, the hydrography of which was executed in 1844, and which accompanies this report, marked B. The map is drawn to a scale of $\frac{1}{1250}$.

In order to locate exactly the work of improvement required, a more complete survey is needed, but for all purposes of material for a report to Congress concerning the requirements of the case, I believe that which follows will be found sufficient.

The village of Narragansett Pier has only within a few years past become a place of any especial importance. It seems to have been selected as a summer watering-place, owing to the possession of a good bathing beach, an unobstructed view of the ocean, and a back country unsurpassed in the surrounding regions for fine scenery, pleasurable drives, and engaging views. At various points in the back country there are cotton-mills and other manufactories in operation. Their productions, as a rule, now find exit to the markets via the Shore Line Railroad, by which route also most of their supplies are obtained. An available harbor here might alter this to the benefit of this place. Considerable capital has been, and is continuing to be, invested here, but chiefly in the construction of summer hotels, no business of any other kind being undertaken further than that necessary to supply the more pressing wants of the winter inhabitants. It seems to be the general opinion of the people of the neighborhood that Narragansett Pier is destined to become one of the most favored watering-places on the coast. The only apparent difficulty is the lack of reliable means of communication with the great lines of travel. The nearest railroad is eight miles distant, hence the summer visitors are forced to traverse this distance by wagon, unless they prefer the route from Newport by sail. Vessels of any class can now only effect a landing in the stillest weather, and if overtaken while at the wharves by a storm, either from the east, northeast, or southeast, are compelled to put to sea or run for Narragansett Bay to prevent being driven ashore. If, therefore, the question of providing a harbor of refuge here for the benefit of general commerce (which will be mentioned further on) is not considered, the matter is resolved into supplying a practicable port for the accommodation of steamboats for summer travel; of harbor and landing conveniences for the numerous pleasure-yachts that frequent these waters during the summer months, and for such merchantmen as may be required to serve the commercial interest of the locality.

By reference to the map submitted herewith, it will be seen that there are two landing places already here. One called the south or lower pier is at the southern extremity of the village proper; the other, the north or upper pier, being near the northern extremity. The intermediate space, a distance of over half a mile, is now occupied almost exclusively with summer hotels. The shore between these two landings is covered with a heavy deposit of boulders. To the northward of the upper pier the beach is composed generally of gravel and fine and coarse sand. In rear of this is a fresh-water pond, having now a general depth of 3 to 4 feet water, whose present level is 5.4 feet above the level of mean low water, but in summer a marshy bog, oftentimes dry. On the intermediate crest are a number of bathing-houses, shown on the drawing. As far as my examination of the sea bottom extended, I found it generally to be fine and coarse sand.

Neither the upper or lower piers, as they now exist, are of any great value as landing-places, except in calm weather; but there is this essential difference, that while the wharves in the neighborhood of the upper pier have been continually exposed to the full strength of the breakers during heavy storms, and constantly filling up with sand, at the lower pier the sea has but little effect on the pier itself, and the sand does not appear to tend to shoal or filling.

Efforts have heretofore been made to provide a wharf that would be available in all weather. In 1836 a corporation known as the Narragansett Pier Company was organized for this purpose, and the old breakwater shown on the drawing was begun, under the personal supervision of Mr. Atmore Robinson, (now cashier of the National Exchange Bank of Wakefield, Rhode Island,) by whom it was finished in 1840, at a cost of some $18,000. Following the line of its general direction, its length from the shore to the sea end was about 435 feet. It was built of heavy blocks of split granite, laid in courses of an average rise of 2 feet, the wall being about 12 feet thick, with both faces nearly vertical, a batter perhaps of 3 inches to the foot.

On the upper or northwest side a wharf was built, forming practically a part of the breakwater. The structure rested entirely on the sandy bottom, except the inshore end and the sea end, which last rests on a rock some 30 feet by 60 feet in size, formerly known as Old Briton. It was soon found that the sea was cutting away the sand beneath the central part of the structure, and attempts were several times made to check this action by casting in large quantities of boulders of all sizes on the sea side to form a riprap, but without avail. This undermining continued, however, notwithstanding everything that could be done, and finally, during the prevalence of a heavy storm from the southeast, and only a few months after the completion of the work in 1840, the central portion, as indicated, toppled over to the northward, where it now remains, a mass of ruins. The only portion of the breakwater now standing in its original condition is the shore end, where it rests on firm natural soil, and the sea end, built on top of the rock before described. Upon the completion of the pier, a steamboat was put on the route connecting this place with Providence and Newport, but, after the breakwater proved a failure, it was withdrawn, leaving the only means of transit to sail-boats and an occasional sloop of the smallest class.

That the breakwater was faulty in its construction is evident, and that it might have been built to withstand these disturbing elements is no doubt true; but that a much better site might have been found south of the lower pier is the general opinion of those familiar with the characteristics of the locality. From the limited observations I was able to make, I feel convinced this opinion is correct. Not having obtained any soundings here, I am unable to go into a detailed description. By reference to the accompanying United States Coast Survey chart marked B, it will be seen that, from the point known as Peaked Rock, (the outcropping of a natural ledge,) a reef of rock marked *a b* (and indicated in heavy dotted red) runs out to seaward, curving to the northward. Within and north of this, and nearly parallel, is another shorter reef, marked *c d*, while north of lower pier is another reef marked *e f*, whose line of curvature is nearly the reverse of that of the other two. These locations are approximate only. The effect of these is to form natural breakwaters against the worst effect of storms from the southeast, northeast, and east, which are those most felt here, so that, while outside these reefs the waves come in with great force and velocity, after passing them much of their power is expended. This is demonstrated from the fact that the lower pier, which was built in the same year (1840) the upper pier was, is still intact. I am told it has never been materially injured, although built of much smaller stone than the upper pier, part indeed being light crib-work filled with small boulders, and this, though at the shore end, yet on the sea-side. During a heavy northeaster I had excellent opportunity to observe the effects on both piers. At the upper pier the waves rolled in with undiminished power, expending their strength upon the unprotected face of the old breakwater. At the lower pier the waves first broke far out on the outer reef, and coming on again, were scattered at the inner reef, so that when they reached the pier, their effects were comparatively harmless. During storms from the northeast, the line of reef marked *e f* has a similar effect, while the upper pier is uncovered.

I am of opinion, therefore, that if any structure of this kind is to be built, the place for it is within the line of inner reef south of the south pier, beginning on shore at some favorable point north of Peaked Rock, and following the general direction of the reef into deep water. How far seaward it should be carried, and its other dimensions of cross-section, can only be determined after a careful and minute survey in favorable weather. On so exposed a coast any breakwater must be strongly built or it will infallibly be destroyed, but it is believed a much cheaper and lighter structure would stand at this point when a far heavier work at the upper pier would fail of its object.

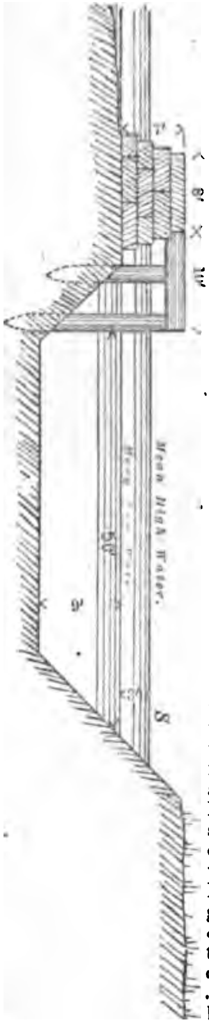
It has been suggested to make an inner artificial harbor here by inland cutting. Two points are proposed: one to utilize the pond in rear of the bathing-beach by cutting through the beach and dredging the cut and the pond to the necessary depth, the other to cut into the low ground south of the south pier, protecting it from encroachment from the sea by a suitable sea-wall. The first would be an expensive and probably useless undertaking, since the cut would fill with sand even if the basin could be kept open. This is shown by the drift of sands about the wharves near by, already referred to. The profiles on the drawings (horizontal scale, $\frac{1}{1250}$; vertical scale, $\frac{1}{125}$) from exhibit the depth of this pond, its present level above mean low water, and the general profile of the intermediate beach. The pond bottom is a stratum of black mud from 3 to 6 feet in thickness, overlaying hard clay and sand and some rock.

I submit no estimate for this scheme, it being considered impracticable.

The project of making a basin at the south pier appears more feasible. Here there is already a natural basin of low ground, surrounded with high hills, having an area of about two or more acres, with a general height of about 7 feet above mean low water. The beach immediately in front of this is low and flat, composed of coarse gravel and some sand, and covered with boulders as far up as high-water mark. Back of this the ground is marshy, in which a small stream from the back hill is lost. If this were excavated and properly protected, with a breakwater at its entrance, it is believed no difficulty would be experienced in keeping it open. The present piers will, I think, perform this without any special alteration. I am told the space intermediate between them is constantly increasing in depth by the effect of the waves and tidal eddy formed here. From my observation I think this true.

The proprietors of the lower pier, Messrs. Clark & Cottrell, have proposed to build a heavy sea-wall along low-water line parallel to the shore, beginning at the shore end of the south wharf and running south some 250 feet. Inside this they propose excavating a canal, the entire length of the wall, 50 feet wide, with a depth of 9 feet at mean low water, the entrance being between the present *pier-heads. This* would provide safe wharfage for a steamboat and room for *several vessels besides,* which would meet all the present requirements, and could at any time be enlarged as might be needed, by cutting further into the adjacent low ground. Any breakwater built to seaward here would require to be similar in its construction and dimensions to one of the first two planned for the harbor at Block Island, Rhode Island, by the Board of Engineers, of which General Hartman Bache, Corps of Engineers, was president, the estimates for which, published in Senate Mis. Doc. No. 81, Fortieth Congress, second session, are, for one 500 feet in length, $372,000; or, for an increase of 300 feet in length, making a total of 800 feet, the sum of $553,798. Such a structure would cost fully as much here as at Block Island. The plan of inland cutting would be vastly cheaper, and would, I believe, give entire satisfaction to the people interested. Abundant stone of suitable character is afforded by the neighborhood for the construction of the wall. The basin can best be excavated with pick and shovel, and the material removed with carts. If necessary, a coffer-dam can be put in it, though it will not probably be required. The excavation can at any time be completed or increased with a dredge, after there is water enough to float the machine in. The capacity of the basin can at any time be increased by cutting further into the low ground by the same means.

Section of sea-wall and basin; scale, 1 inch to 20 feet.



NOTE.—The piling shown within the sea-wall may be omitted here and placed on the opposite side of the basin at S.

The following estimate of the cost of this work is submitted:

To construct a sea-wall and basin at Narragansett Pier, Rhode Island, for local purposes.

To construct a sea-wall 315 feet in length, 7 feet in height above mean low-water level, having a batter of 3 inches to 1 foot on each side, and a width of 8 feet on top, 770.58 cubic yards of stone, at $10 per yard	$7,705 80
To excavate material within the basin described, giving a basin 280 feet in length by 50 feet in width, and having a depth of 9 feet at mean low water, 6,999.75 cubic yards, at 50 cents per yard	3,499 88
	11,205 68
Add, for engineering and other expenses, 10 per centum	1,120 56
Total	12,326 24

Within this sea-wall, and on either side of the basin that may be selected, a wharf on piles may be constructed to give increased wharfage facilities. If placed next the sea-wall, 10 feet additional width over that of the top of the sea-wall will suffice. This would lessen the width of the basin to 40 feet available space. If placed on the inner side of the basin, it may encroach still less. I have made no estimate for this as it would more properly be done by the steamboat owners for whose benefit it will be used.

The sketch below gives a general profile of the proposed work. Its general location is shown on the map.

In my belief the only thing that would warrant the construction of a heavy seaward breakwater here would be for the purpose of forming a harbor of refuge for the foreign and coastwise trade through Long Island Sound. With such a harbor now being made at Block Island by the construction of a breakwater there, and with the excellent harbors of Dutch Island and Newport in Narragansett Bay, an additional one here would seem unnecessary. During the prevalence of heavy southeasters, vessels that do not or cannot make the future harbor of Block Island, can as well run for Dutch Island or Newport as for Narragansett Pier. It is out of the track of vessels bound anywhere except to Narragansett Bay and its ports of Providence, Newport, Fall River, &c. If they could not make Narragansett Bay they could not the pier. If an additional harbor of refuge is needed in this part of Long Island Sound, the place for it is on the east side of Point Judith, which lies directly in the path of not only the coasters bound east or west, but in that also of the shipping coming in from or going out, on the Atlantic by way of the sound. The only point in favor of the construction of a breakwater at Narragansett Pier is that it would increase by one the number of harbors of refuge on the coast. This would also be true were it built anywhere else in the sound, and the problem is to select the best position for such works. Some system of harbors of refuge for our coasts must ultimately be devised, and one of the governing principles in their location is the selection of salient points of the coast, near the line of travel, that vessels in distress or seeking refuge from heavy storms can readily make with the least departure from their course.

As an instance of a similar case to this of Narragansett Pier, I would refer to the breakwater at Church's Cove, on the east shore of the Saughkonnett River or eastern entrance to Narragansett Bay, immediately north of Saughkonnett Point, shown on the accompanying sketch marked A. This work was begun in 1836, under the supervision of the Engineer Bureau, and in September, 1838, had reached the length of 120 feet, when, says Captain W. H. Swift, Topographical Engineers, in his report to Colonel J. J. Abert, Chief Topographical Engineers, dated March 26, 1839, "A violent storm during that month (September) swept away about 20 feet of the end of the work, and the gale of January last overthrew about 30 feet more of it, leaving, at this time, between 60 and 70 feet uninjured."

In 1839 "this was repaired, and 90 feet more added, making the total length 210 feet." Much of this has since tumbled over at the sea end, so it now affords but little more protection to the harbor of Church's Cove than the natural point of rocks on which it stands. It was intended solely as a harbor of refuge.

Allusion has been made to this breakwater because an examination of the records would show that a work was made here by the United States, and it might be desirable, in a general consideration of the subject, to know its relation to Narragansett Pier. As it now is, the work at Church's Cove (which I visited in company with yourself last fall) is nearly useless, and it may be disregarded in enumerating the harbors of refuge.

The fate of this work is further instructive, by indicating what character a work must have to withstand the waves of this part of the coast. It is evident that nothing in the form of a breakwater to meet the shock of the waves of the Atlantic, but a work of the first class in quality and of great cost, can be relied upon.

The proposed work at Narragansett Pier is excavation of a basin behind a point already protected, and the building of a sea-wall along a part of the shore where the effect of the waves is broken by outlying reefs. It seems, therefore, practicable to do this work at a reasonable expense.

Narragansett Pier is in the Newport collection district, that city being the nearest port of entry. The revenue collected at Newport during the fiscal year ending June 30, 1870, was $19,141 36. The nearest light-house is at Beaver Tail, the south point of Connanicut Island, distant three and one-quarter miles. At Point Judith, five miles to the southward, is another light-house, both comprised in the third light-house district. Narragansett Pier is within seven miles of the large military works defending the western and middle entrances to Narragansett Bay.

I am, general, very respectfully, your obedient servant,

J. A. JUDSON,
Assistant Engineer in charge of Survey.

Brevet Major General G. K. WARREN,
Major Corps of Engineers, Newport, Rhode Island.

T 24.

SURVEY OF SOUTHPORT HARBOR, CONNECTICUT.

The report of this was made by me on the 14th of January last. It possesses an interest as illustrating the condition of a former public improvement, and helps to understand the general subject of improving harbors on Long Island Sound. I have therefore annexed it to this report. No appropriation was made for improvement at the last session of Congress.

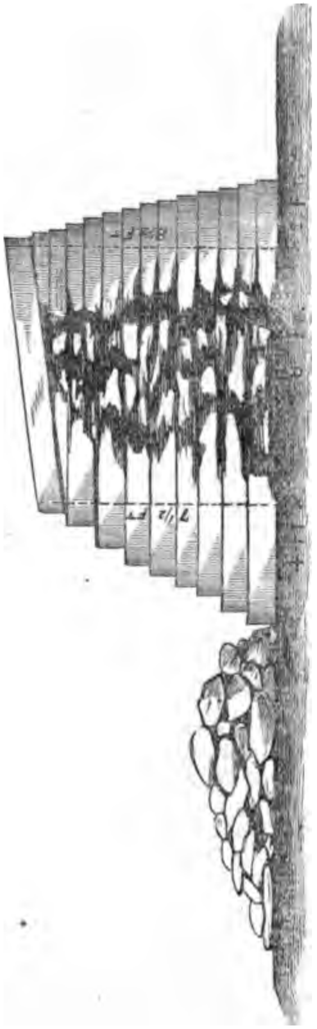
ENGINEER OFFICE, UNITED STATES ARMY,
Newport, Rhode Island, January 14, 1871.

GENERAL: I have the honor to submit the following report in relation to the survey of the Southport Harbor, Connecticut, which I was directed to make by your letter of instructions dated July 21, 1870, and which survey was authorized by section 2 of the *act making appropriations* for the improvement of rivers and harbors, approved July *11, 1870.*

The history of the public works at this place, under the Engineer Department of the Army, is as follows:

In 1826 a survey was made by Lieutenant Colonel John Anderson, United States Topographical Engineers, under orders from Major General Macomb, Chief Engineer, commanding the Department, the map and report of which you furnished me. The works which Colonel Anderson recommended were a breakwater of stone, running southward from the sand-spit opposite Southport, out into the sound, from the high-water line to about the low-water line, a distance of about 1,420 feet. Also, a dike of earth 1,450 feet long, extending northward from the sand-spit along the edge of the low sunken marsh ground. The object of the breakwater was to prevent the sand which moved westward along the shore by the waves from falling into the channel of Mill River, and to increase the action of the current along the channel. The object of the dike was to compel the water, which at the flood-tides flows eastward into the low ground north of the sand-spit, to all pass around its north end, and thus increase the scouring action of the current on the main channel in front of the dike.

In the spring of 1829, Colonel James G. Totten, United States Engineers, under instructions from Brigadier General Gratiot, colonel commandant of United States Engineers, visited Southport, and made arrangements for carrying on the work for which an appropriation of $6,097 (the amount estimated for by Colonel Anderson) had been made that year.



Colonel Totten's report was dated May 16, 1829. From this it appears he arranged for the work to be carried on under the agency of a committee of responsible residents of Southport. He gives a description of the character of the work to be built, and his recommendations were substantially carried out. This work has stood so long that the description of it in Colonel Totten's report possesses peculiar interest.

Colonel Anderson's plan for the sea-wall was to make it 14 feet wide on the bottom, 7 feet high above common low water, and 8 feet wide on top; but as this was thought too low, Colonel Totten recommended that it be made 1 foot higher, and the top be made inclined, so as to make it 7½ feet high on the outside, and 8½ on the inside, above common low water.

The following sketch and description of this wall are taken from Colonel Totten's report:

* * * * * * *

"The outside slope should be formed of long and large stones exclusively, and all of them laid as headers.

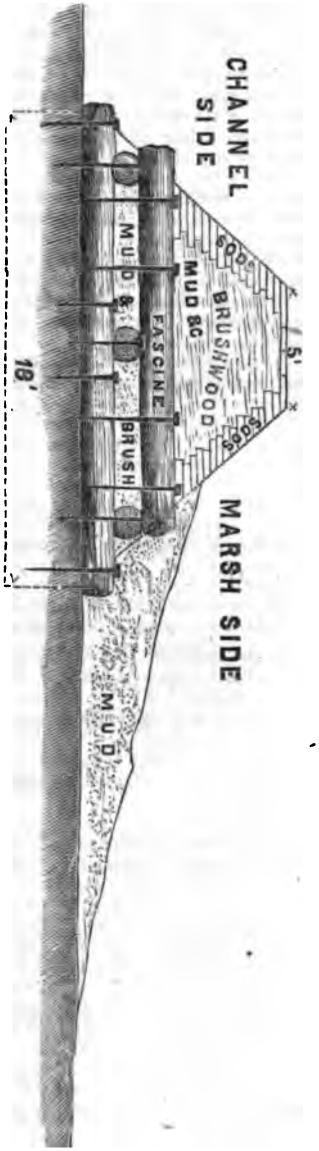
"The inner slope may be formed of stone somewhat smaller, but these also should be laid as headers. The top should be formed of stones reaching entirely across the breakwater. The interior of the mass may be made up of stones of all sizes compactly laid. To prevent the action of the undertow upon the foundation on the sea-side, various expedients may be resorted to. The best, perhaps, will be to place brushwood against the bottom, confining it there by inserting some of the ends under or between the stones, by laying saplings lengthwise upon it, and on these laying a few large stones. The effect of this deposit of brushwood will be to retain the sand which may be washed by the sea against the breakwater, thereby giving additional strength and guarding against the corrosive action of the undertow."

* * * * * * *

In relation to the dike between the river and the sunken ground, Colonel Totten says:

"As Lieutenant Colonel Anderson's report does not give any dimensions for this work, I propose the following for the parts now referred to.

"A layer of facines should first be laid side by side, at right angles to the direction of the dike, each facine being 18 feet long and pinned to the bottom with four pickets 4 or 5 feet long, the pickets having each a hook at top. Upon the bed of facines thus formed, a line of facines should then be laid near the outside, another near the inside, and a third in the middle, each of the three lines extending entirely across the outlet, these being well secured to the bottom by hooked pickets. A little brushwood should be laid between these, and then mud from the marsh be thrown in and well compacted, to form a firm bed for a second layer of facines laid crosswise, which are to be picketed to the bottom as were the first. This course will probably bring the structure to a level with the top of the marshy island; if not, there should be another course of facines laid lengthwise, and, if necessary, a third course of facines crosswise. Having obtained the level of the surface of the marshes, the higher part of he dike should be faced on the sides with marsh-sods, the interior being formed of alternate thin layers of brushwood and mud, care being taken to have the mud evenly spread in all cases, and well compacted by ramming or otherwise. On the side next the marshes a mass of mud should be placed against the dike, reaching above the highest facines and sloping gently away to the distance of 18 or 20 feet. This is indispensable, and should be formed by successive additions as the several courses of facines are laid. The height of the dike is not given on the profile, because it will vary in different places. The top should everywhere be about 1 foot above high water of spring tides.



"The dike, where it is to lie upon the marshy islands, should be constructed in the same way as the upper part of the profile; that is to say, be faced with marsh-sods and be filled with brushwood and mud. It will tend greatly to increase the strength of the upper part of the dike to secure the sods to the interior by pins, (not hooked,) about 18 inches long, one to each sod, and by permitting small branches of the brushwood to be interspersed between the layers of sod, and it will tend to the durability of the whole structure to use cedar-brush only, both loose and for the facines.

"To insure the stability of the northern end of the dike, it will be expedient to turn that end abruptly around the east and southeast, as will be shown on a plan to be sent to the committee."

* * * * * * *

The work was carried on according to the above general recommendations, except that the revetment on the river-side was made of stone instead of sods.

In 1832 an additional appropriation of $4,490 was made; in 1836 another of $1,500; and in 1837 another of $1,000; making a total for these works of $13,087 43.

The report of Captain W. H. Swift, United States Topographical Engineers, to Colonel J. J. Abert, Chief of Topographical Engineers, dated September 26, 1838, gives a description of the condition of the work at that time. From this the following extract is made:

* * * * * * *

"The breakwater is of stone, 440 yards long, 18 feet wide at bottom, 7 feet at top, and from 8 to 12 feet high, varying with the profile of the ground upon which it is built. The top is formed of large flat stone 7 feet long, and thus extending over the entire width. It extends from a beacon at the mouth of the river to the southwest point of a sand-bluff opposite the narrows at the lower part of the village. The work is substantially put up, and, with the exception of half a dozen of the capping-stones which have been partially displaced by the force of the waves, the whole is in good condition, and, in the opinion of the agent, has answered the purpose for which it was built. The dike commences at the point of the sand-bluff opposite the village at which the breakwater terminates, and about 250 feet north of it. It extends along the margin of some marsh islands (in the prolongation of the direction of the breakwater) 450 yards to the *upper end of the village. It* is revetted on the west or river side. The revetment is *4 feet thick at base, 2* feet at top, and 8 feet high, and batters from the river about one-fourth. The whole is laid upon a grillage of about 6 feet in width, projecting about 1 foot on each side of the stone-work, and carried sufficiently below the surface of the ground to secure a good foundation. The grillage is formed of 3-inch plank, laid transversely of the wall, and fastened together by plank of same description laid longitudinally. The whole width of the dike at base is 15 feet, and originally it was 8 feet wide at top, but a great portion of the backing (composed of sods from the neighboring marsh) has been abraded by the effects of storms. The sodding at the outside of the dike was laid upon facines, and a portion of the sods were fastened to each other by means of pickets. Still, from the nature of the material used, the dike is liable to injury at every storm, and must in a short time be seriously impaired unless some precautionary steps are adopted to prevent it. A revetment upon the east side of the dike, similar to that on the west side, and laid in a similar manner, and of the same dimensions, will secure this most effectually. For this purpose I submit an estimate, (marked A,) and recommend that an appropriation be asked for to carry the same into effect.

"At the extremity of the breakwater, and at the outer bar, beacons are erected. They are built of crib-work of timber and filled with stone.

"The dredging of sand, &c., from the channel of the river was of small amount, and was done principally with oxen and scrapers. Where mud occurred it was excavated by men with shovels.

"Vessels drawing 8 feet can enter this harbor at high water. The above works were completed in the spring of 1837, and the funds entirely expended."

* * * * * * * * *

A.

Estimate of the cost of a revetment-wall for the east face of the dike at Southport Harbor, Connecticut.

The wall required is 1,320 feet in length, 4 feet at base, 2 feet at top, and 8 feet in height, laid up with a batter of ¼.

1,267.20 perches (of 25 cubic feet) rubble-wall, at $1 50	$1,900 80
35,640 feet (board measure) of 3-inch plank, for grillage, at $15 per M	534 60
660 pounds 6-inch cut spikes, at 7 cents	46 20
Carpentry and contingencies	100 00
	2,581 60

* * * * * * * * *

The following report on these works was made in December 8, 1830, to General Gratiot, colonel commandant of engineers, by Colonel Totten, United States Engineers:

"I have just returned from an examination of the works at Mill River, Connecticut.

"Both the dike and breakwater have been finished to the altitude first determined on, and seem well to fulfill their object. Differences in the nature of the ground beneath have, however, caused an unequal subsidence in both, which, without impairing their stability in the least, seemed, nevertheless, to require some addition to the present height. Indeed, to have the full advantage of the improvement, there should be something added, even to the highest parts, as it is ascertained that they are below full spring tides. The channel has been deepened by dredging throughout its whole length, and the improvement of the navigation is universally, I believe, acknowledged to be very great. The channel has yet to be widened by the dredge.

"The work appears to have been conducted with a very strict attention to economy, and with great skill and judgment."

* * * * * * * * *

Captain Swift again made a report to Colonel J. J. Abert, dated September 8, 1839, in which he referred merely to his previous report, and renewed his former recommendation for an appropriation for repairs.

I am not aware that any further appropriation was made by Congress for repairing this work. On this work coming into my hands in July last, I directed my assistant, General Theodore G. Ellis, civil engineer, to make a personal examination of it and let me know what was required. From him I learned that, in view of our limited means, an estimate of all that was needed to be done here could be made without any expensive survey.

Subsequently I procured a copy of the map on a scale of 1 to 10,000, made by the

United States Coast Survey in 1835, and I visited the place personally in December last.

That the works should be in as good state of preservation as they are, considering their character, surprised me. Along the breakwater for the space of about 1,000 feet there was but one breach in the wall, and only about 70 yards of the capping-stones were thrown off or broken. Mr. Joseph Jennings and Mr. W. B. Meeker, who accompanied me, explained this by saying that they had themselves kept the work in repair by replacing stone thrown off, and rebuilding parts of the wall that had been knocked down by the sea, by using the crews of their vessel while lying in port, and by an expenditure besides, annually, of about $60. The capping-stones are of very inferior quality, being too small in size and composed of a mica schist that wears away and breaks easily.

The residents of Southport had managed to supply the broken capping-stones thus far by taking them away from where the wall had become covered with sand by the beach growing out seaward, but this resource had about failed them, and the wall was getting in a worse condition than it had ever been before. The breakwater, besides, is about 2 feet too low, and the waves throw the sand over it at the point where the beach and the breakwater join, and it does not thus effectually arrest the sand as it was intended it should. The action of the waves at this point is worth considering. The heavy waves roll in from the southeast, the line of the crest making an angle with its breakwater and the beach at the same time, the same as the base of a triangle does to its adjacent sides. The result is to concentrate the action at the apex of this triangle, and the water and sand from over the breakwater at that point and into the harbor. A point of sand has thus grown out from the breakwater on the inside until it has reached the current caused by the tide flowing out of the harbor, and then it is swept down and spread out at the entrance. Thus the principal object of the breakwater is defeated. The sand which the breakwater has arrested has extended the beach seaward about 350 feet, and inefficient as it is from being too low, it perfectly demonstrates the effectiveness of such structures built the proper height. To my mind, the illustration which this work gives of the operation of the forces along the sound is worth, for this alone, far more than what it has cost. I think that, at the point where the breakwater joins the beach, it should be about 4 feet higher. This height should be carried out about 300 feet, then it might drop down 2 feet, so that we need to raise the rest of the breakwater only 2 feet. As the sand beach makes out, the stone can be taken from the highest part and moved out to keep pace with it.

This will cost as follows:

To restore the wall in good condition uniformly to its present level, 100 cubic yards of stone, at $6	$600 00
To raise the wall 4 feet for a distance of 200 feet, using large split granite blocks about 7 feet in length, doweled and clamped together, 200 yards, at $15 per yard	3,000 00
To raise about 800 feet of wall 2 feet, with large blocks of granite clamped and doweled, 385 yards, at $15 per yard	5,775 00
	9,375 00

The dike along the sunken ground is in a tolerably fair condition, but the waves have washed out some of the earth filling between the revetments. The sod revetment on the marsh side has been replaced by stone, (but my information does not say when,) so that it has now a stone revetment on both sides. It would probably average 1½ feet of filling to be replaced along the whole of it. It would be desirable, too, to carry the whole dike up about 2 feet higher than it now is.

The revetment wall is 2 feet thick on top, and the length of the dike is about 1,450 feet, so there would be required about 400 cubic yards of revetting wall, at $4 per yard	$1,600 00
The part of the dike on top, between the revetting walls, will average about 4 feet in width, and the filling 3½ feet in thickness, where the revetment is raised, requiring about 750 yards. This should be of coarse gravel or small stones, picked off of the field, or the small spalls from the quarry, at say $1 per yard	750 00
There should also be a stone ice-breaker built at the north end of the dike, to cost say	500 00
Total for the dike	2,850 00
Total for both breakwater and dike	$12,225 00

The foregoing will meet the immediate wants of the harbor. No estimate is thought required for dredging. The channel, at best, at mean low water, with the present extent of the breakwater, is not more than 2 feet deep, and any deposit that forms in it is readily removed by the residents, who use the ordinary road plow and scraper. The mean rise of the tide is $6\frac{6}{10}$ feet, and of spring tide, $8\frac{8}{10}$ feet. Although I presume the light-house inspector is already aware of it, I will state here that more enrockment is required about the beacons recently built to make them secure.

To make Southport Harbor as good as it might be would require the extension of the breakwater to the 6-foot curve, about 250 feet beyond the outer beacon. Whenever this is done the harbor can probably be dredged out and maintained at a depth of 7 feet at mean low water.

Southport is situated on the railroad between New York and New Haven, and contains about ——— inhabitants. Its harbor is open all the winter, and in that respect is very valuable. All through the winter season farming produce, from the surrounding country, can be shipped at low rates to New York market.

I have not been able to get any statement of the amount of business. A number of vessels are owned here, engaged in foreign and coastwise trade.

Southport is in the Fairfield collection district. The nearest port of entry is Bridgeport, distant about seven miles by rail.

The nearest light-house is at Fairweather Island, Black Rock Harbor.

Accompanying this report is a copy of the United States Coast Survey map of Southport, which has the lines of works at that place marked upon it, and I have noted some changes since 1835 approximately in red ink.

I recommend that an appropriation of $12,225 be made to repair these works.

Yours, respectfully,

G. K. WARREN,
Major of Engineers, Brevet Major General, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

T 25.

SURVEY OF HARBOR AT STONINGTON, CONNECTICUT.

This survey was authorized by section 3 of the act approved March 3, 1871, and the duty was assigned to me by letter from the Engineer Headquarters dated March 21, 1871. This survey was finished in July, but the map is not yet finished, and I shall have to submit a report and plan of improvement, as desired by the people of Stonington, at some time during the coming winter, and as soon as practicable.

Stonington is a port of entry, and the revenue collected there during the fiscal year ending June 30, 1871, was reported to me by the collector at about $2,500.

APPENDIX W 1.

BOSTON, MASSACHUSETTS, *August* 30, 1871.

GENERAL: I have the honor to make the following brief reports in relation to the sea-walls under my charge, in this harbor, for the year ending June 30, 1871, to wit, the sea-wall of the Great Brewster Island, of Deer Island, and of Lovell's Island.

The sea-wall of the Great Brewster Island I have to report as in good condition, all the bluffs being well protected by this work, and the apron-facing of "shell"-stone on the south part as still securing the level portion of the island, or old drift there, from further abrasion, and no further expenditure appears to be required for the present at this island. The larger and better portion of the buildings, and the piles and lumber of the wharf have been removed, for reconstruction, to Long Island, as not farther required at this position, and especially as the ownership of the island is in the city of Boston, the *site* of the sea-wall only being deeded to the United States by said city.

The three sea-walls of Deer Island are also in an essentially good condition, and there is no immediate pressing necessity for farther works there, though, as stated in my last annual report, (of September 16, 1870,) to which I would respectfully refer, for rebuilding some further portion of the wall at the North Head, and for protecting the foundation or relaying the riprap stone now lying along nearly the whole length of these walls at the base, I would repeat the estimate therein made as expedient and necessary to give a proper security to these walls, for $18,000.

As to the sea-walls of Lovell's Island, I have to report the wall at the east of the south bluff, built in 1868, as still answering most perfectly the object designed, protecting the bluff and *itself also* securely from all injuries. The arrangement of the lines are such that there is scarcely ever to be found a difference of a single foot in the level of the shingle-drift thrown up along the entire length of the wall and the jettees, resting as this drift does generally, against the second course of masonry only, above the concrete foundation.

But the injuries near the west end of the old wall of "Ram's Head," as described in my last annual report, (of September 7, 1870,) to which I would respectfully refer, I regret to say, are found still to continue, and to require attention, if we would secure the level or drift portion of the island from the danger of a new cut through it from the west end of the Ram's Head wall, directly toward the narrows of the main channel, to the great injury or possible destruction of that main ship entrance.

The estimate at that time made for a continuation of that sea-wall for about 400 feet, and for an apron-facing of shell-stone for about 750 feet farther to the southwest, I have the honor to offer now again for $15,000.

The funds that were available for small repairs of the sea-wall on Deer and Lovell's Islands being undrawn upon the last year, as then reported, now remains on hand, (June 30, 1871,) $732 24.

I am, sir, very respectfully, your most obedient,

H. W. BENHAM,
Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers.

APPENDIX V 1.

Report of Lieutenant Colonel George Thom, Corps of Engineers, upon the works of improvement in his charge, for the fiscal year ending June 30, 1871.

IMPROVEMENT OF THE NAVIGATION OF THE ST. CROIX RIVER, ABOVE THE LEDGE, MAINE.

By an act of Congress, approved March 2, 1867, the sum of $15,000 was appropriated for the improvement of this river, "provided the province of New Brunswick shall contribute and pay to the proper disbursing officer a like sum for said purpose; said payment being made on condition that in no event shall the province of New Brunswick be called upon for more than one-half the sum actually expended for said purpose." As the co-operation of the province is yet to be obtained in this matter, operations have not been commenced. The improvement of its navigation requires its channel to be deepened by the removal of slabs, edgings, and sawdust, which, for thirty years and more, have been accumulating in large quantities from the numerous saw-mills above and near Calais.

For an accurate estimate of the "amount that is required for the entire and permanent completion" of this improvement, a careful survey will be necessary. An examination made by me showed that—

To open a channel 100 feet wide and 10 feet deep, at low water, would require the removal of not less than 100,000 cubic yards of slabs, edgings, and sawdust, which, at 90 cents per cubic yard, would amount to	$90,000
Add for contingencies, (say)	10,000
Total	100,000
Deducting one-half, if paid by the province of New Brunswick	50,000
Amount required on the part of the United States for its completion	50,000

Of this amount, $25,000 could be expended to advantage upon the work during the next fiscal year.

V 2.

IMPROVEMENT OF NARRAGUAGUS RIVER, MAINE.

The improvement contemplated in this river (see report of December 8, 1870) comprises the removal of several bars, ledges, and a vast quantity of boulders which obstruct its navigation from its mouth up to the bridge at Cherryfield, a distance of about seven miles.

By an act of Congress, approved March 3, 1871, the sum of $12,000 was appropriated therefor.

In a project submitted to the Department on the 18th of March, it was recommended that the appropriation made for this work should be applied to the removal of the ledges and boulders, as being the most important obstructions of those requiring attention, and that, owing to the indefinite and varied character of the work, it should be done by hired labor. This project having been approved by the Department, operations were commenced about the middle of April, being the earliest period practicable on the subsidence of the freshets. A subsequent rise of water, however, delayed active operations until about the middle of May. Up to June 30, 1871, about 250 boulders, weighing, in all, about 550 tons, have been removed from the bed of the river at and above Small's Point, including one of about 80 tons, at Cherryfield, and thirty others, weighing from 3 to 15 tons each.

Amount appropriated by act of March 3, 1871, for this work, (as above)	$12,000 00
Amount expended up to the 30th of June, 1871	1,904 39
Total amount available July 1, 1871	10,095 61

This amount, available July 1, 1871, is deemed sufficient for removing the remainder of the rocks and ledges which obstruct the navigation of the river, and it is probable that they will all be removed before the 30th of November next.

The several bars which obstruct its navigation between the lower landing (near its mouth) and Cherryfield, referred to in the report of December 8, 1870, have been mostly caused by a deposition of sawdust, which has been, and is still being, thrown into the river from the saw-mills at and above Cherryfield. It is therefore recommended that no appropriation be asked for removing those bars until the throwing in of sawdust be discontinued by such State laws as may be necessary to effect it.

V 3.

EXAMINATION AND SURVEY OF NARRAGUAGUS RIVER, MAINE.

Narraguagus River is situated in the towns of Millbridge and Cherryfield, in the southwestern part of Washington County, State of Maine. It is navigable from its mouth, at Millbridge lower landing, nearly up to the bridge at Cherryfield, a distance of about seven miles. At Millbridge this river is crossed by a draw-bridge and causeway, two miles above its mouth, and five miles below the bridge, crossing it at Cherryfield. The tide rises and falls from 10 to 14 feet at Millbridge, and from 3 to 7 feet at Cherryfield, varying within those limits at the intermediate falls. The general course of the river is very straight, except at Strout's Point and Collins's Point, which are about five miles above its mouth. The general depth of water in the river is, with the exception of certain bars, ledges, and boulders to be hereinafter noted, as follows, viz: It is navigable up to the upper landing at Millbridge, (one and three-fourths miles above its mouth,) for steamers and other vessels drawing from 7 to 8 feet of water at mean low water; and a coastwise steamer touches regularly at this landing, when the tide permits two bars below it to be crossed. From the upper landing to Small's Point, a distance of two miles, there are about 15 feet of water at mean low water, or 14 feet at ordinary high water; and from Small's Point to Dyer's Wharf, at Cherryfield, a distance of three miles farther, (or five miles above the upper landing,) there are 3 feet at mean low water, or about 8 feet at ordinary high water; and from Dyer's Wharf up to the *bridge at Cherryfield* (one-fourth of a mile) there is a depth of from 1 to

2 feet at mean low water, or from 6 to 7 feet at ordinary high water. This river, however, is obstructed in several places by bars, ledges, and boulders, which renders its navigation very difficult and dangerous; and in consideration of the vast trade in lumber and other products, of which this river is the outlet, and which, in the present unimproved condition of the river, has to be transported in scows down to the wharves below the bridge at Millbridge for shipment, it is very important that the obstructions to the navigation of the river by sailing-vessels should be removed wholly or in part; the following being those that especially require attention, viz:

1. Near the lower landing, at its mouth, there is a bar composed of mud about 100 yards in width, and with but 6 feet of water upon it at mean low water; and another bar below the upper landing and opposite Fickett's Point, also about 100 yards in width, and with but 6 feet of water upon it at mean low water. This upper bar is a part of a middle ground formed of sand and sawdust, which forms and disappears with the varying storms and currents, and to permanently improve this by deepening it, it is believed would be impracticable. The channel over the lower bar, however, might be deepened to better advantage, so as to admit steamers and other vessels drawing from 7 to 8 feet into the river at all stages of the tide. Just above the lower landing there is a boulder (weighing from 5 to 6 tons) lying on the western edge of the channel, and three more in the main channel near the upper landing, all which are dangerous to navigation, and should be removed.

2. At the falls, (which are about two and a half miles above the lower landing, or half a mile above the bridge at Millbridge,) there are two large boulders in the channel near the right (or western) shore, one of which weighs about 30 tons, and is bare at low water, and the other from 8 to 10 tons. Just below the falls, also, there are numerous boulders weighing from 5 to 10 tons each, of which about twelve should be removed, so as to open a channel through them, and the edges of the channel should be properly marked. There is also a *ledge* making out from the eastern shore (at the falls) which extends downwards from three to four hundred feet and part way across the practicable channel of the river. This ledge has an average width of about 10 feet on its top, and only about 2 feet of water upon it at mean low water, and it should be reduced for an average depth of 3 feet, and for an extent of about 200 feet. From the falls up to Small's Point, a distance of about one mile, the navigation of the river is unobstructed.

3. At Small's Point, which makes out from the eastern shore, there are about forty boulders (weighing from one-half to five tons) lying in about 4 feet of water at low water, and many of them bare at low water. These are dangerous from the setting down of the ebb-tide upon this point, and should be removed.

4. The Brothers (about one-fourth of a mile above Small's Point) consist of six large boulders of from three to eight tons, which lie in the channel, the largest three being bare at low water, and they all should be removed.

5. Below and near Leighton's Wharf, (about one-half of a mile above the Brothers,) there is a sand-bar 300 feet wide, with but 2 feet of water upon it at mean low water; and another bar of sand and sawdust above Leighton's Wharf, which is 200 feet wide, and has but 2 feet of water upon it at mean low water. These bars should be excavated so as to have a channel through them 4 feet in depth at mean low water, and 100 feet in width. There are also eight small boulders on the upper bar, which should be removed.

6. At Shaw's Head, (one-fourth of a mile above the Brothers, and half way between the bridges at Millbridge and Cherryfield,) there are two boulders in the channel at this place, 5 feet deep at mean low water, both being bare at low water, which also should be removed. There is also a small sand-bar just below Shaw's Head, about 100 feet wide, and with but 13 feet of water upon it at mean low water. As this is a shifting bar, it is not deemed advisable to undertake its improvement.

7. About three-eighths of a mile above Shaw's Head there is still another bar, which is about 300 feet across, and with 1½ feet of water upon it at mean low water. Here is required the excavation of a channel 100 feet in width, and 4 feet in depth at mean low water, which would give a channel of that depth from Shaw's Head up to Strout's Point, five-eighths of a mile above.

8. At Wyman's (or Collins's) Point, which is about three-fourths of a mile above Shaw's Head, on the west bank of the river, there are several loose rocks in the channel, as well as from eight to ten more in the channel below, between Wyman's and Strout's Point. All should be removed.

9. About 400 feet below Sprague's Rips, (one-half of a mile above Wyman's Point,) there is a boulder in the channel, weighing about five tons, and having about 2½ feet of water upon it at mean low water; also, at Sprague's Rips there are two more boulders in mid-channel, weighing from five to ten tons each, both bare at low water in 5 feet of water. All these should be removed.

10. At Hanson's Rips, (one-fourth of a mile above Sprague's Rips, or one mile below the bridge at Cherryfield,) there is a shifting sand-bar 300 feet wide, with but 2 feet of water upon it at mean low water, but it is not deemed advisable to undertake its improvement.

11. At Snow's Rips, (one-half of a mile above Hanson's Rips,) there are three or four boulders lying in 4½ feet of water, and bare at low water, and below these are four more, weighing from two to five tons each; all of which should be removed.

12. Above Dyer's Wharf, (which is in Cherryfield, and about one-fourth of a mile below the bridge,) there is a very large boulder, weighing from 75 to 100 tons, lying in the natural channel of the river; also several small boulders in the river above it; all of which should also be removed.

The following is an estimate of the cost of the foregoing improvements, viz:

1. Dredging 18,000 cubic yards, at 50 cents	$9,000 00
2. Blasting and removing sunken ledge at the falls, 200 cubic yards, at $30	6,000 00
3. Removing from the channel below the bridge at Millbridge four boulders, at $50 each	200 00
4. Removing 120 boulders from the channel above the bridge, (including the large one near Dyer's Wharf,) at an average cost of $25 each	3,000 00
Adding for contingencies	1,800 00
Total	20,000 00

This amount, it is believed, would be sufficient for the entire and permanent completion of the improvements herein recommended to be made, all which could be profitably expended upon the work during the next fiscal year.

The following additional information is furnished in compliance with the requirements of the law providing for the examination and survey of this river.

This river is in the collection district of Machias, and the port of entry is at Cherryfield, at the head of navigation.

The nearest light-house is the Pond Island light, distant about six miles from Millbridge.

The amount of revenue collected at the port of Cherryfield for the fiscal year ending June 30, 1870, as furnished by the United States deputy collector of customs at that port, was $2,120 37.

I am also indebted to the same authority for the following information, which exhibits to what extent the commerce of the country would be benefited by improving the navigation of the river in the manner as above recommended:

During the year 1869 there were shipped from this river as follows, viz:

Long lumber, 17,100,000, at $16 per M	$273,600 00
Laths, 14,175,000, at $2 25 per M	31,893 75
Shingles, 23,200,000, at $3 50 per M	81,200 00
Miscellaneous, viz, hoops, staves, bark, &c	30,000 00
Total	416,693 75

Upon this river there are six very fine water-powers, which could be so improved by the construction of dams at the head-waters of the river, at a cost of a few thousand dollars, that the most severe drought would have no effect upon them. And if the river was made navigable even for a small class of vessels, the cost of transportation would be so reduced that the raw material could be brought here and manufactured with profit by factories built upon these water-powers. As it is now, everything has to be transported five miles in scows, and for this reason factories have never been built. There is capital on the river sufficient to build such factories, and a desire to do so, but it cannot now be made profitable. Clear out the river, and improve its navigation, and it will be done.

Again, on account of the cost of transportation, a vast amount of short lumber is destroyed, which would otherwise be manufactured. A vast amount of wood, made at the various mills, is also destroyed, which would otherwise be shipped, and with profit, while it would not now pay to scow it down the river and then ship it.

Again, at the head-waters of this river, there are vast tracts of hard wood and hemlock timber lands as yet untouched. But it will not pay to cut this hard wood into cord-wood, haul it to the river, scow it five miles, and then ship it; consequently no ship-timber or cord-wood is shipped. Whereas it would pay to haul it to Cherryfield, at the head of navigation, and ship it direct from there to market, and this, doubtless, will be done if the river is improved. And so with hemlock timber; it will not pay to peel it, haul it to Cherryfield, and scow it down the river for shipment, so great is the waste and cost of transportation. The consequence is that no hemlock bark is shipped, nor are any hemlock logs cut, for the reason that they will not float down the streams unless stripped of their bark, so that only about one-half as much lumber is manufactured as there otherwise would be. Whereas, if the bark could be shipped and the hemlock manufactured, there would be 30,000,000 feet shipped instead of but 17,000,000 feet, as now, and this would necessitate the building of more mills to manufacture this lumber.

Again, there are reasonable hopes that with a reduced cost of transportation the people of this section of the country would be induced to raise and export hay. For these and many other reasons it is confidently believed that the commerce of the country would be greatly benefited by the proposed improvement of the navigation of this river.

V 4.

IMPROVEMENT OF SULLIVAN RIVER AND SULLIVAN FALLS, MAINE.

This river is navigable from its mouth up to Franklin, a distance of about nine and a half miles, and the only obstructions to its navigation are Hatcher's Rock and Ledge, in the falls, and the old bridge piers, about one mile above the falls.

The estimated cost of the improvement of these obstructions is as follows, viz:

1. Removal of Hatcher's Rock:	
a. Amount required to pay for removing 270 cubic yards, contracted for at $35 per cubic yard	$9,450
b. And for removal of remaining portion to a depth of 10 feet below mean low water, 700 cubic yards, at $30 per cubic yard	21,000
2. Removal of portion of ledge near Hatcher's Rock, 50 cubic yards, at $30 per cubic yard	1,500
3. Removal of three stone bridge-piers at $2,000 each	6,000
4. Iron spindles on Half-tide Ledge and Low-Water Rock, at $1,250 each	2,500
Add for contingencies, say	3,550
Total	44,000
By act of Congress of March 3, 1871, there was appropriated for this work the sum of	10,000
Amount still required for its completion	34,000

Under the appropriation of March 3, 1871, a contract was made with Mr. George W. Townsend, of Boston, Massachusetts, (after advertising for proposals,) first, for the removal of a portion of Hatcher's Rock, at $35 per cubic yard; and, second, for the removal of such of the bridge-piers as might be required, not exceeding two, at $2 50 per ton.

It was subsequently decided to confine the work to the removal of so much of Hatcher's Rock as could be done under the appropriation, viz, 270 cubic yards. This rock is a granitic formation, with a large excess of feldspar. At a distance of 7 feet below mean low water its extreme length is 92½ feet, and its extreme width 57½ feet, with an area of 509 square yards. The difficulty attending its removal is much increased by the very great velocity of the currents in which it lies, which are as follows: Maximum velocity of flood-tide just above Hatcher's Rock is from eight to nine miles an hour; and of the ebb-tide, eight miles an hour. Actual slack-water lasts only from 0 to 10 minutes. Flood-tide, 20 minutes after slack-water, has a velocity of four miles an hour; and the last ebb, 20 minutes before slack-water, is from two and one-half to three miles an hour.

* The contractor commenced work about the 1st of June, and removed about 130 cubic yards during the month, that is, up to the close of the fiscal year.

By act of Congress of March 3, 1871, there was appropriated for this work, (as above)	$10,000 00
*Amount expended upon the work up to July 1, 1871	226 97
Total amount available July 1, 1871	9,773 03
Additional amount required for completing the work, as above, (all of which could be profitably expended thereon during the next fiscal year)	$34,000 00

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* NOTE.—On the 1st of August, 1871, the contractor had removed 270 cubic yards *of Hatcher's Rock*, in completion of his contract, by which the appropriation was *exhausted.* This work has already greatly improved the channel of the river in giving *an increased* depth of 4 feet over Hatcher's Rock.

It is respectfully suggested that not less than $25,000 be appropriated for this work—that being the amount required for completing the removal of Hatcher's Rock and the ledge near it.

Accompanying this is a map, showing the position and extent of Hatcher's Rock and the ledge near it, in Sullivan Falls, as well as the bridge-piers in the river above the falls.

The papers described as follows are also hereto appended, viz:

1. Copy of advertisement inviting proposals for removing obstructions in Sullivan River, Maine.
2. Abstract of bids for same.
3. Abstract of contract for same.

Abstract of proposals received for the improvement of Sullivan River, Maine.

No. for reference.	Nature of work.	Name of bidders.	Quantity.	Price.
1	Removing three stone piers above the falls.	Alfred Cleaves, Portland Maine.	....	$6,000 00.
2	Remove Hatcher's Rock	George A. Bailey, East Boston, Mass.	Measured in bed.	51 00 per cubic yard.
3	Make to depth required on stone piers.	.........do	....	5 00 per ton.
	Do all work and furnish materials.	..........do	....	110 00 per day.
4	Remove the stone piers	George W. Townsend, Boston, Mass.	On the vessel.	2 50 per ton.
5	Remove Hatcher's Rock.........	..........do	Measured in bed.	35 00 per cubic yard.
6	Do all the work, furnish necessary materials, except exploders.	..........do	....	80 00 per day.

Abstract of contracts made for the improvement of Sullivan River, Maine.

No. for reference.	Nature of work.	Names of contractors.	Quantity.	Price.
1	Removal of Hatcher's Rock...	George W. Townsend, Boston, Mass.	Measured in bed..	$35 per cubic yard.
2	Removal of stone bridge-piers.	......do	2,240 lbs. per ton..	$2 50 per ton.

V 5.

EXAMINATION AND SURVEY OF SULLIVAN RIVER AND SULLIVAN FALLS, MAINE.

Sullivan River lies in the towns of Sullivan, Hancock, and Franklin, in the southern part of Hancock County, in the State of Maine, and empties southwardly into Frenchman's Bay. It is navigable from its mouth up to Franklin, a distance of about nine and one-half miles.

Sullivan Falls forms a part of Sullivan River, and are situated between the towns of Hancock and Sullivan, distant about three and one-half miles above the mouth of the River, at Crabtree's Point. Below the falls the tide rises and falls from 10 to 14 feet, being an average of 12 feet; in the falls the average rise and fall of tide is 8 feet; and at

Franklin, the head of navigation, six miles above the falls, the average rise and fall is about 5 feet.

Vessels of 16 feet draught can ascend the river as far as the falls at mean low water, whilst vessels of but 6 or 7 feet draught can pass through the falls at low slack-water, (low slack-water being at 2 to 3 feet on the flood-tide,) or of 12 to 14 feet draught at high water; but from the falls up to Franklin, vessels can carry 13 feet of water at low water, or 18 feet at ordinary high water. This river is easily and safely navigated throughout, excepting at the falls and the bridge-piers above the falls, (at both of which places very dangerous obstructions exist,) as well as at several ledges below the falls, which only require suitable beacons to mark their locality.

The nature and extent of these several obstructions are as follows, viz:

1. Below the falls—*Crabtree's Ledge* is about one-third of the way across from Crabtree's Point (the mouth of the river) to Bean's Island. It lies in the channel, and has about 8 feet of water upon it at mean low water. Large vessels have struck upon it, and may do so again unless its locality be marked by a buoy.

Half-tide Ledge, about one and one-fourth miles below the falls, is on the eastern edge of the channel, there being 18 feet of water at low water, at a distance of about 100 feet to the westward of the ledge. It is covered at about half-tide, and is a very dangerous ledge to navigators, and especially to those who are strangers in the river. A spar-buoy has been placed upon this ledge, but it was carried away by the ice last winter. An iron beacon could be easily built upon it, and would, it is believed, resist the ice and storms to which it would be exposed.

Low-water Rock is on the western side of the channel, opposite Half-tide Ledge, its top being uncovered at low water. This also should be marked by an iron beacon to enable vessels to "beat up" from the point below.

2. *Sullivan Falls.*—Here occur the greatest obstructions to the navigation of the river. At this place the river becomes abruptly contracted (above and below) to a width of about 400 feet, about one-third of its general width, for an extent of one-fourth of a mile; where, with a fall of about 7 feet, the current becomes irresistible to navigation on the ebb-tide. It is, however, navigable at and near high water; also after the tide has flowed 2 or 3 feet, so as to create slack-water in the falls; and sometimes upward with a favorable wind, during the remainder of the flood-tide.

These difficulties, great as they are, are very much increased by the existence of several ledges in the falls, the most dangerous of which is known as Hatcher's Rock. This rock lies in mid-channel about half way down the narrows, (or falls,) and is, on an average, about 40 feet in length by 25 feet in width. It is 1 foot out of water at ordinary low water; while the water is about 7½ feet deep around it at low water, or 10 feet at low slack-water.

In addition to this rock there is a ledge, or island, known as "Dry Ledge."

Dry Ledge, which is for the most part uncovered in all stages of the tide, is about 150 feet in length by 100 feet in width at its widest part, the lower end of it being near the foot of the narrows. This ledge is continued for a distance of about 200 feet farther up, in smaller detached portions, all which, together with Dry Ledge, divide the river into two channels, (both of which are navigable,) which are connected by small channels passing *between the detached* ledges above Dry Ledge.

Now the flood and ebb tidal currents set directly upon Hatcher's Rock, and a vessel in passing it takes whichever side of it the wind compels it to do. If it passes on the south side into the south channel, (that is, south of Dry Ledge,) it is exposed to a detached sunken ledge, making out from near the right (south) shore, upon which vessels have several times struck.

This ledge is about 20 feet long by 15 feet wide, and has about 1 foot of water upon it at ordinary low water; and it should be removed so as to obtain a depth of 6 feet upon it at ordinary low water, or 14 feet at high water. Hatcher's Rock should also be removed to the same depth, thereby making navigation unobstructed to that depth through both the north and south channels in the fall.

3. The *Bridge piers*, about one mile above the falls, are eleven in number, and are composed of *grout* thrown into the bed of the river, (the channel being 18 feet deep at mean low water,) with dimension-granite built upon the grout. They are from 75 to 110 feet apart in the clear, and are about 25 feet long by 15 feet wide on top, the grout foundations having a slope of about 45° down to a depth (in the channel) of about 18 feet at ordinary low water, thus leaving narrow and rapid channels between them. They were built about eighteen years ago for a bridge, but were carried away by the violent current, (which is very strong at this place, especially at half-ebb tide,) and by floating ice, before the superstructure was placed upon them. The tops of what remains of them are now bare at low water only; so that they are a very serious and dangerous obstruction to navigation, and are no longer of any public use or value. In order to give a channel through them, which shall have sufficient width (say 350 feet) and depth, it will be necessary to remove three of these piers to a depth of 10 feet below ordinary low water.

The estimated cost of the foregoing improvements is as follows, viz:

1. Iron beacons on Half-tide Ledge and Low-water Rock, at $12 50 each	$2,500 00
2. Removal of Hatcher's Rock 500 tons, at $50	25,000 00
3. Removal of ledge near Hatcher's Rock, 125 tons, at $50	6,250 00
4. Removal of three bridge-piers above the falls, say	1,000 00
	34,750 00
Add for contingencies, say	3,250 00
Total	38,000 00

This amount, it is believed, would be sufficient for the entire and permanent completion of the improvements herein recommended to be made, all which could be profitably expended upon the work during the next fiscal year.

The following additional information is furnished in compliance with the requirements of the law provided for the examination and survey of this river and falls:

Sullivan River and Falls are in the collection district of Frenchman's Bay, and the port of entry is at Sullivan.

The nearest light-houses are at Goldsborough, called Prospect Harbor light and Winter Harbor light, both about fifteen miles distant from the mouth of Sullivan River.

The amount of revenue collected at the port of Sullivan for the fiscal year ending June 30, 1870, (as furnished by the United States deputy collector of customs at that port,) was $602 12. But this fact conveys very little idea of the large amount of business that is done upon this river and through the falls, or of the very great benefit that commerce would derive from the improvements so important and necessary to be made, as probably nine-tenths of the vessels that coast on this river belong elsewhere, and consequently do their business at other custom-houses.

The nature and extent of the commerce of this river (as given by the deputy collector) for the last fiscal year, is as follows, viz:

Shipped from the town of Franklin, at the head of navigation on this river, 10,000,000 feet of sawed lumber, equal to about one hundred cargoes; and spars, piling, railroad ties, wood, staves, heading, &c., seventy-five cargoes.

Shipped from Sullivan, (above the falls,) of granite, about 80,000 feet, equal to fifty cargoes; all of which are obliged to pass through the falls, and oftentimes ten or fifteen sail of these vessels arrive at the falls at the same time, making it very difficult for all to pass through without some one of the number getting on to the rocks.

It should also be added that, so dangerous are these rocks, vessels sometimes have to lie above the falls for days, and even weeks, to wait for a favorable wind and tide for avoiding these rocks in descending the falls.

In view of all the facts herein presented, the necessity for improving the navigation of the river and falls, as recommended, is very evident. The dangers of navigation are such, that in a very few years the losses sustained in commerce would far exceed the amount required for the removal of those difficulties, and they are all of such a character that their improvement would be permanent, and not require further appropriations to be made for them when once completed.

V 6.

IMPROVEMENT OF UNION RIVER, MAINE.

Under the appropriation of $15,000 made by the act of Congress of July 11, 1870, a contract was made on the 10th of September, 1870, with Messrs. Morris & Cumings, of New York City, for opening a channel 150 feet in width through the slabs, edgings, and sawdust, down to the natural bed of the river, between the wharves at Ellsworth and the head of the narrows, a distance of about half a mile, for the sum of $12,000. Work was commenced under this contract on the 19th of September, and continued up to the middle of December, when it was suspended on account of the ice. It was resumed about the 20th of April, as soon as practicable after the opening of the river, and is still continued, with the probability that the channel will be completed about the 1st of October, under an extension of time for its completion up the 30th of November, 1871. Up to the 30th of June, about 40,000 cubic yards of slabs, edgings, &c., had been removed, making a channel about 100 feet in width. Twenty-four boulders (each weighing from 3 to 45 tons) were removed during the year from the channel of the river between Fullerton's Point and Ellsworth, all which were serious obstacles to its navigation; and about 150 tons of ledge have been removed from the eastern channel at its mouth. This channel has been heretofore but little used, on account of the numerous ledges and boulders which obstruct it; but it is contemplated to remove all the ledges and boulders from it, (as well as from the bar at the mouth of the river,) and thereby render the channel available for safe navigation at all times, with 4½ feet of water at mean low water, or 16½ feet at ordinary high water. It is also contemplated to erect iron beacons at the mouth of the river on Fullerton's Point and Hall's Point, and to remove all the rocks, wrecks, and other obstructions to navigation up to the wharves of Ellsworth. It is believed that these improvements will be completed before the close of navigation this season. The appropriations made for this work are as follows, viz:

1. By act of Congress July 11, 1870	$15,000 00
2. By act of Congress March 3, 1871	15,000 00
Total	30,000 00
Amount expended during the fiscal year ending June 30, 1871, not including outstanding liabilities on contract, &c.	3,813 98
Total available July 1, 1871	26,186 02

This amount is deemed to be sufficient for completing all the contemplated improvements, and it is therefore recommended that no further appropriation be asked for.

Abstract of proposals received for the improvement of Union River, Maine.

No. for reference.	Nature of work.	Names of bidders.	Price.
1	Dredging channel 100 feet wide; additional width, same ratio.	Geo. P. Wescott, Portland, Me	$40,000
2	Dredging channel 80 feet wide	Meliatiah K. Chase	14,000
	Every additional 10 feet in width	do	1,500
3	Dredging channel 100 feet wide	Morris & Cumings, New York City	8,000
	Every additional 10 feet in width	do	800
4	Perform the work, furnishing everything, including all labor.	do	$300 per day.

Abstract of contracts made for the improvement of Union River, Maine.

No. for reference.	Nature of work.	Names of contractors.	Price.
1	Dredging channel 100 feet wide down to the natural bed.	Morris & Cumings, New York City	$8,000
	Each additional 10 feet	do	800

V 7.

IMPROVEMENT OF PENOBSCOT RIVER AT BANGOR AND BELOW, MAINE.

The navigation of this river, one of the most important in the New England States, is very much obstructed by several bars and ledges at Bangor and below, more especially between Bangor and Crosby's Narrows, about three and a half miles below. These bars are, for the most part, composed of slabs, edgings, and sawdust, which have been thrown into the river from the saw-mills above, and for the last fifty years and more have accumulated to an average depth of about 10 feet, and in some places to a depth of more than 18 feet, causing serious obstacles to its navigation. It is also obstructed by several large sunken ledges and boulders, known as Independence Rock, Steamboat Ledge, Gulliver's Rock, and others. To excavate these deposits down to the original bed of the river, would require the removal of more than 5,000,000 cubic yards; but for opening a channel 200 feet in width with a depth of 12 feet below low water in the lowest stages of the river would require—

1. The excavation of about 100,000 cubic yards, edgings, &c., which, at $1 per cubic yard, would cost	$100,000 00
2. The excavation of Independence Rock to its base, say 800 cubic yards, at $25 per cubic yard	20,000 00
3. The excavation of ledge near Steamboat Ledge, say 600 cubic yards, at $25 per cubic yard	15,000 00
4. Removing Gulliver's Rock, 40 cubic yards, at $25 per cubic yard	1,000 00
5. Excavating ledge near Green's Pier, 85 cubic yards, at $25 per cubic yard	2,125 00
Add for contingencies, say	16,875 00
Total amount required for the work	155,000 00

Amount appropriated for this river by act of Congress of July 11, 1870	$15,000 00
And by act of Congress of March 3, 1871	50,000 00
Total	65,000 00

Amount required for completing the contemplated improvements, (as above)	$90,000 00
Amount expended during the year ending June 30, 1871, (not including outstanding liabilities)	7,559 37
Available balance on hand July 1, 1871	57,440 63

The work done in the year 1870 under the appropriation of July 11, 1870, was confined to the excavation of portions of Independence Rock and Steamboat Ledge, until suspended by the closing of the river by ice in the month of November. In April, 1871, after the second appropriation was made, proposals were invited for opening a channel through the obstructions in three localities, where most necessary, to a width of about 200 feet and depth of 12 feet, requiring, in all, about 33,000 cubic yards of excavation. The lowest bids for this work were those of Mr. A. Boschké, of Boston, Massachusetts, and on the 27th of May a contract was made with him therefor, at prices as follows, viz:

1. For upper bar, extending down to Low's Ledge, at Bangor	$18,320 00
2. For middle bar, (lying between Crosby's ship-yard and Edmond's steam saw-mill)	7,400 00
3. For lower bar, near steam-mill	3,375 00
Total	29,095 00

Operations were commenced by Mr. Boschké, under his contract, on *the 19th of June,* at the upper bar; and on the 30th of June the channel at that place was about one-eighth finished. Operations were also resumed on the ledge near steamboat wharf, on the 3d of June, (which was the earliest date practicable after the freshets,) and 360 tons were removed during the month, making about 400 tons removed from that ledge during the year; 80 tons were also removed from Independence Rock during the year.

Abstract of proposals received for the improvement of Penobscot River, Maine.

Number for reference.	Names of bidders.	For a channel 150 feet through upper bar, 1st.	For a channel 200 feet through upper bar.	For a channel through middle bar, 2d.	For a channel through lower bar, 3d.
1	W. R. Stockbridge, Boston, Mass	$17,910	$23,880	$9,950	$4,477 50
2	John B. Curtis, Portland, Me	15,000	20,000	7,500	7,500 00
3	A. Boschké, Boston, Mass	13,320	18,320	7,400	3,375 00

Abstract of contracts made for the improvement of Penobscot River, Maine.

Number for reference.	Name of contractor.	For a channel 150 feet through upper bar, ledge excepted.	For each additional 50 feet in width upper bar, ledge excepted.	For a channel through middle bar, ledge excepted.	For a channel through lower bar, ledge excepted.
1	A. Boschké, Boston, Mass	$13,320	$5,000	$7,400	$3,375

V 8.

IMPROVEMENT OF KENNEBEC RIVER, MAINE.

The plan now in progress for the improvement of this river consists in straightening and deepening its channel by dredging through the several shoals, and the removal of the boulders and ledges which obstruct its navigation between Richmond and Augusta, Maine.

The following appropriations have been made for this work, viz:

1. By act of Congress approved June 23, 1866	$20,000 00
2. By act of Congress approved March 2, 1867	30,000 00
3. Allotted under act of Congress approved April 10, 1869	15,000 00
4. By act of Congress approved July 11, 1870	15,000 00
5. By act of Congress approved March 3, 1871	15,000 00
Total	95,000 00

A contract was made May 23, 1867, with Mr. Augustus R. Wright, of Geneva, New York, for dredging a channel through Shephard's Point Shoal and Hallowell Shoal; on the 29th of September, 1868, the channel was completed through both shoals to the required width of 75 feet and a depth of 7 feet at low water in the lowest stages of the river. Another contract, dated January 29, 1868, was made with Mr. Wright for dredging a channel through Britt's and Gage's Shoals—both above Hallowell—and on the 30th of November, 1870, the channel was completed through both shoals to a width of 100 feet, and a depth of 6½ feet at low water in the lowest stages of the river. Another contract, dated May 9, 1871, was made with Mr. Wright for dredging a channel through Hinckley's Shoal, (between Gardiner and Hallowell, Maine;) and on the 30th of June, 1871, the channel was completed to the required width of 100 feet and a depth of 7 feet at low water in the lowest stages of the river. Another contract, dated May 9, 1871, was made with Mr. Wright for increasing to 100 feet the width of the channel (previously dredged to a width of 75 feet) through Shephard's Point and Hallowell Shoals; and on the 1st of July, 1871, he had made some progress at Shephard's Point Shoal, after having completed his contract at Hinckley's Shoal. The contract requires the work to be completed on or before the 20th of November next, but it is quite probable that the work will be completed about the 1st of October.

During the past year about fifty boulders, weighing from 500 pounds to 20 tons, (making altogether more than 100 tons,) have been removed from the channel and shoals, whereby the safety of its navigation has been greatly improved.

Amount of funds available for this work on the 1st of July, 1870, was	$346 50
Amount transferred from the allotment made to Saco River improvements under the appropriation of April 10, 1869.	322 34
Amount appropriated by act of Congress July 11, 1870....	15,000 00
Amount appropriated by act of Congress March 3, 1871, including $5,000 for improvements between Richmond and Gardiner, not embraced in previous estimates for this river	15,000 00
Total	30,668 84
Amount expended during the year ending June 30, 1871 ..	15,928 81
Total available July 1, 1871	14,740 03
Of this amount there is applicable to the "improvement of the river between Gardiner and Richmond," the sum of..	4,976 30
And the balance to the river above Gardiner	9,763 73

This balance of $9,763 73, it is believed, is sufficient to complete all the improvements contemplated for the river above Gardiner.

But for that part between Richmond and Gardiner there will be required as follows:

1. For removing ledge in channel near Nehumkeg Island to a depth of 12 feet below mean low water, 30 cubic yards, at $30 per cubic yard	$900 00
2. Removal of ledge and boulders in channel below Gardiner, 40 cubic yards, at $30 per cubic yard	1,200 00
3. Dredging a channel through the Upper Sands Bar, 100 feet wide and 10 feet deep at mean low water, 6,000 cubic yards, at 50 cents per cubic yard	3,000 00
4. Dredging channel through bar at the head of Swan Island in the western channel, 7,000 cubic yards, at 50 cents per cubic yard	3,500 00

5. Removing ledge from channel near Richmond, say 100 cubic yards, at $30 per cubic yard	$3,000 00
Add for contingencies	1,376 30
Total	12,976 30
Amount available July 1, 1871, (as above)	4,976 30
Additional amount required for completing improvements proposed, (as above)	8,000 00

Which amount can be profitably expended upon the work during the next fiscal year.

In furtherance of a project to improve this part of the river to the extent allowed by the amount appropriated therefor by act of Congress March 3, 1871, (viz, $5,000,) on the 10th of June proposals were invited, (to be opened on the 10th of July,) 1, for removing the sunken rock in the channel near Nehumkeg Island; and, 2, for dredging the proposed channel through the Upper Sands Bar.

Abstract of proposals received for the improvement of Kennebec River, Maine.

No. for reference.	Nature of work.	Names of bidders.	Quantity.	Price.
			Cub. yards.	
1	Dredging through Hinckley's Shoal, below Hallowell, Maine.	Augustus R. Wright, Geneva, New York.	*10,000	Fifty cents per cubic yard.
2	Dredging Shephard's Point, Hallowell and Britt's Shoals, near and above Hallowell, Maine.	......do	*30,000	Forty cents per cubic yard.

* More or less.

Abstract of contracts made for the improvement of Kennebec River, Maine.

No. for reference.	Nature of work.	Names of contractors.	Quantity.	Price.
			Cub. yards.	
1	Dredging through Hinckley's Shoal, below Hallowell, Maine.	Augustus R. Wright, Geneva, New York.	*10,000	Fifty cents per cubic yard.
2	Dredging Shephard's Point, Hallowell and Britt's Shoals, near and above Hallowell, Maine.	......do	*30,000	Forty cents per cubic yard.

* More or less.

V 9.

IMPROVEMENT OF THE NAVIGATION OF THE "GUT," NEAR BATH, MAINE.

The following appropriations have been made for this work, viz:

1. By act of Congress approved July 11, 1870	$10,000 00
2. By act of Congress approved March 3, 1871	6,500 00
Total	16,500 00

The following improvements are those which required the most attention, and those to which it has been deemed advisable to apply the appropriations made for this work:

1. The removal of Boiler Rock to a depth of 10 feet at mean low water.

2. The removal, to a depth of 9 feet at mean low water, of the ledge extending from Boiler Rock northward toward the shore.

3. The removal of two wrecks of vessels lying in mid-channel, above and near Upper Hell Gate, (the "Gut.")

4. Placing buoys to mark the new channel above and below Upper Hell Gate.

5. Dredging a channel through the bar above Upper Hell Gate to a depth of 10 feet below mean low water.

6. The removal of a sunken rock from mid-channel near Tibbetts's Point.

7. Removing a projecting portion of the ledge which contracts the channel of Upper Hell Gate on its southern side.

Operations were commenced in the "Gut," on Boiler Rock, on the 12th of September, 1870, (under the appropriation of July 11, 1870,) and continued until the 17th of December, during which period the following work was accomplished toward the improvement of its navigation, viz:

1. *On Boiler Rock.*—This rock originally had but 3 feet of water upon it at mean low water, and its contour, at a depth of ten feet, was about 25 feet long and 15 feet wide. It has been blasted off to a depth of not less than 10 feet at mean low water, in which operations 168 tons have been raised and moved away, while more than 500 tons have been blasted off and lodged in the deep water by which it is surrounded. By the first blast of 300 pounds Dualin (No. 5) one large piece, weighing more than 300 tons, was detached and removed laterally several yards from this rock, and was afterward broken up in deep water, where it now remains.

2. *On Boiler-Rock Ledge.*—This ledge is the continuation of Boiler Rock toward the point on the north shore above. Its contour at a depth of 9 feet below mean low water was originally about 80 feet in length, and ranging in width from 15 to 35 feet, some parts of it having but 5 feet of water upon it at mean low water. This ledge has been blasted off to a depth of not less than 9 feet at mean low water; in which operations about 250 tons were raised and removed, and a large quantity (probably about 100 tons) was scattered into deep water.

Boiler Rock and Ledge are a granitic formation, and are variable in character, containing more or less fine feldspar, quartz, and mica, in separate seams.

The difficulties in operating upon them were very much increased from their position immediately below the "Gut," where the velocity of the current is 4.6 miles per hour at three-quarter ebb; 1.9 miles per hour at three quarter flood; 3.2 miles per hour at low water; 2.1 miles per hour at high water, it being slack-water at half flood, and just before one-quarter ebb, when it is of but few minutes' duration. Just after the one-quarter ebb the current is 3.6 miles per hour.

3. Two wrecks of vessels (of about 100 and 200 tons respectively) have been broken up and removed from the main channel, about three-fourths of a mile above Upper Hell Gate.

4. A large buoy has been placed on a ledge uncovered at half tide on the western edge of the channel, about one-fourth of a mile above Upper Hell Gate. Two buoys have also been placed below Upper Hell Gate, so as to mark out the northern channel, which the removal of Boiler Rock and Boiler-Rock Ledge has made available for navigation.

By the above operations nearly all the appropriation of July 11, 1870, became exhausted.

Under the new appropriation of March 3, 1871, operations were resumed at the "Gut," and continued up to the 25th of May, 1871, during which period the following work was accomplished, viz:

A channel was dredged through the bar above the Upper Hell Gate to a width of 100 feet and a depth of 10 feet at mean low water—requiring the excavation of 5,550 cubic yards.

Several buoys were placed to mark this new channel. The amount that was expended on all the above-named improvements during the fiscal year ending June 30, 1871, was $13,562 47; leaving a balance on hand July 1, 1871, of $2,937 53.

This amount, it is believed, is sufficient to complete the work which now remains to be done, which is embraced in items 6 and 7 above.

This work will probably be completed before the 1st of December, 1871. It is respectfully recommended that no further appropriation be asked for.

V 10.

IMPROVEMENT OF ROYALS RIVER, MAINE.

On referring to the report made on the 14th of December, 1870, upon an examination of this river, it will be seen that its navigation is both difficult and dangerous from bars and rocks, in the following places, viz:

1. Gravel Point Bar, a short distance below the wharves of Yarmouth. This requires an excavation of about 25,000 cubic yards, in order to obtain a depth of 5 feet at mean low water; the estimated cost of which, at 50 cents per cubic yard, is	$12,500 00
2. Ledges at Call'em Point, Big Rocks, and Little Rocks, requiring an excavation of about 1,300 cubic yards, the estimated cost of which, at $15 per cubic yard, is	19,500 00
Adding for contingencies, say	3,000 00
Making the estimated cost of the contemplated improvement	35,000 00
By an act of Congress, approved March 3, 1871, there was appropriated therefor	10,000 00
Additional amount required	25,000 00

This amount can be profitably expended during the next fiscal year.

It having been decided that the whole amount of the appropriation should be applied to dredging a channel through Gravel Point Bar, proposals were invited for this work, and on the 26th day of May, 1871, a contract was made with Mr. W. R. Stockbridge, of Boston, Massachusetts, for commencing the work on or before the 1st of July, and to be completed not later than the 15th of November, 1871.

Amount expended during the fiscal year ending June 30, 1871	$181 77
Amount on hand available July 1, 1871	9,818 23

The papers described as follows are hereto appended, viz:

1. Abstract of proposals for same.
2. Abstract of contract for same.

Abstract of proposals made for the improvement of Royals River, Maine.

No. for reference.	Nature of work.	Names of bidders.	Quantity.	Price.
1	Dredging	George C. Fobes, Portland, Maine	Not to exceed 25,000 cubic yards.	70 cents per cubic yard.
2	....do	N. E. Munson, Boston, Massachusetts		60 cents per cubic yard.
3	....do	Morris & Cumings, New York City		60 cents per cubic yard.
4	....do	Augustus R. Wright, Geneva, New York		50 cents per cubic yard.
5	....do	W. R. Stockbridge, Boston, Massachusetts		49½ cents per cubic yard.

Abstract of contracts made for the improvement of Royals River, Maine.

No. for reference.	Nature of work.	Name of contractor.	Quantity.	Price.
1	Dredging	W. R. Stockbridge, Boston, Mass	Not to exceed 25,000 cubic yards.	$0 49½ per cubic yard.

V 11.

EXAMINATION AND SURVEY OF ROYAL'S RIVER, MAINE.

Royal's River empties into Casco Bay at a point about ten miles northeast from Portland, Maine. It is navigable for a distance of two and a half miles, from its mouth at Parker's Point up to the wharves at Yarmouth. It has, however, several ledges and sand-bars in its channel, which render its navigation both difficult and dangerous, and which it is very important should be removed, and by removing which the depth of its channel would be much increased. The locality, extent, and character of these several obstructions are as follows, viz:

1. *Near Brown's wharf*, about one and a half miles below Yarmouth. Between this place and Call 'em Point, one-quarter of a mile above, there are several very dangerous ledges in the river, bare at low water. First, in ascending, are "Little Rocks," on the southern edge of the channel; next, "Big Rocks," on the northern edge of it, and then the ledge at *Call 'em Point,* on the southern shore of the river.

The ebb-tidal current from above Call 'em Point strikes directly upon the ledge at that point, and thence is deflected upon "Big Rocks," lying nearly in the middle of the river, and thence again upon "Little Rocks," nearly opposite to Brown's wharf. The current is here very strong, and the difficulties of navigation are great, which makes it very necessary that these ledges should be, to some extent, improved. The ledge at Call 'em Point requires about 300 cubic yards of excavation, and a portion of "Big Rocks" about 400 cubic yards, to obtain 5 feet of water thereon at mean low water; and at "Little Rocks" about 600 cubic yards, in order to bring the ledge down even with the river bottom at this place; in all, 1,300 cubic yards of rock excavation.

2. *Kelly's Rock*, next above Call 'em Point, lies near the channel on the south shore, in a dangerous position, but requires only a buoy or iron spindle to mark its locality.

3. *Wolfe's Point* is a shoal making out from the north shore, and extending nearly across the river, which is here very wide, leaving but a very narrow and crooked channel for navigation near the south shore. It would not, in my opinion, be advisable to attempt to improve this place permanently, by dredging or otherwise, as it is more than probable that the shoal would soon fill and form again.

4. *Gravel Point.*—Vessels can ascend the river with 7 feet of water at average low water, or 16 at high water, up to East Yarmouth wharf, and even 100 yards above it; but here the river begins to shoal, and so continues up to Gravel Point, a distance of one hundred yards, with but 1 foot of water at mean low water.

This is the most serious obstacle to the navigation of this river, and should be improved so as to give a channel 100 feet in width, with 5 feet of water at mean low water, to do which would require about 25,000 cubic yards of dredging.

With these improvements, comparatively safe navigation would be obtained up to the wharves at Yarmouth, with 5 feet of water at mean low water, or 14 feet at high water.

The estimated cost of these improvements is as follows, viz:

1. Excavation of the ledges at Call 'em Point, "Big Rocks," and "Little Rocks," 1,300 cubic yards, at $15 per cubic yard...	$19,500
2. Dredging the shoal near Gravel Point, 25,000 cubic yards, at 50 cents per cubic yard..................................	12,500
Add for contingencies..	3,000
Total	35,000

This amount, it is believed, will be sufficient for the *entire* completion of the improvements contemplated, as well as for their *permanent* completion, unless it may perhaps be necessary to again excavate the shoal at Gravel Point. Of this amount, $20,000 could be profitably expended upon these improvements during the next fiscal year.

The following additional information is furnished, in compliance with the law providing for the survey of this river.

Yarmouth is in the collection district of Portland and Falmouth, and its port of entry is at Portland, Maine.

The nearest light-houses are those in Portland Harbor and one on Half-way Rock, all distant from ten to twelve miles.

The nearest forts are those in Portland Harbor.

The amount of revenue collected at Portland, the nearest port of entry, for the fiscal year ending June 30, 1870, as furnished by the collector of customs at that port, was as follows:

Duties	$807,685 56
Tonnage and hospital	23,661 02
Total	831,346 58

Yarmouth is one of the largest ship-building towns in the State of Maine, and a very considerable amount of tonnage hails from that town, as will appear by the accompanying abstract, A, furnished by the collector of customs. I would also respectfully refer to the accompanying paper marked B, as exhibiting a statement of facts tending to show to what extent the commerce of the country will be promoted by the works of improvement contemplated for this river, this statement having been prepared and furnished by some of the leading business men of the place, who are most familiar with the subject.

In consideration of all the facts herein presented, and of the great necessity for the improvement proposed, I would respectfully recommend that attention be given to the matter at as early a day as practicable.

A.

Abstract of merchant vessels hailing from Yarmouth, Maine, taken from "List of Merchant Vessels of the United States, belonging to the Customs District of Portland and Falmouth," as returned to the Bureau of Statistics, at Washington, June 30, 1870.

Nine ships.	Three barks.	Eight brigs.	Ten schooners.	Six sloops.	Total.
Tons.	*Tons.*	*Tons.*	*Tons.*	*Tons.*	*Tons.*
954.88	554.99	376.12	295.62	32.54	....
1,493.98	565.77	395.99	43.56	28.82	....
1,055.81	766.10	487.08	121.11	69.17	....
1,243.11	....	421.38	9.50	8.96	....
1,812.94	....	404.96	46.71	30.76	....
1,457.30	....	143.75	61.00	33.09	....
1,114.65	....	429.32	317.69	....	....
1,172.59	....	442.97	96.22	....	....
1,214.44	....	....	13.21	....	....
....	....	....	152.06	....	....
11,519.70	1,886.86	3,101.57	1,159.68	203.34	17,871.15

B.

The following is a summary of the principal manufactures and products of the town of Yarmouth:

4,000 tons of vessels built yearly, some of which are ships of 1,800 tons each; one of this size now being built.

50 boats being built per year.

3,000 tons of clay shipped per year.

2,000,000 bricks shipped per year.

2,000 tons granite shipped per year.

6,000 bushels potatoes shipped per year.

300,000 cans corn shipped per year.

300 barrels clams shipped per year.

1,000,000 feet southern pine received per year.

250 tons iron and spikes received per year.

2,500 tons coal received per year.

300,000 bushels grain received per year.

500 tons plaster received per year.

2,400 tons paper-stock received, and the product in paper sent to other markets.

1,200 bales cotton consumed in the manufacture of bags, yarn, &c., and the same sent to other markets.

The amount of commerce at Yarmouth for the year ending June 30, 1870, was as follows:

	Estimated value.
Clay exported	$45,000 00
Bricks exported	20,000 00
Granite exported	20,000 00
Potatoes exported	3,600 00
Canned corn exported	75,000 00
Clams exported	2,400 00
Southern pine received	35,000 00
Iron and spikes received	25,000 00
Coal received	20,000 00
Grain received	300,000 00
Plaster received	2,500 00
Paper-stock received	192,000 00
Cotton received	120,000 00
Paper manufactured and sent away	270,000 00
Cotton manufactured and sent away	192,000 00
Molasses and sugar consumed	18,000 00
Value of vessels built, (1870)	180,000 00
Value of boats built, (1870)	3,000 00
Total	1,523,500 00

It is estimated that, by having the obstructions to navigation in the river removed, it will increase ship-building 100 per cent.; it will decrease risk and insurance greatly probably $10,000; it will increase the commerce of the place (it will be safe to say) 50 per cent. in the course of a few years; it will decrease the freight on all cargoes, as vessels now charge from 25 to 30 cents per ton more, on account of these obstructions.

V 12.

IMPROVEMENT OF PORTLAND HARBOR, MAINE.

The contemplated works for the improvement of this harbor consist in the completion of the breakwater to an additional extent of about 190 feet, and the excavation of the channel through the Middle Ground Bar to a depth of 20 feet below mean low water, and to an average width of about 300 feet.

Up to June 30, 1870, 90,315 cubic yards had been excavated at the Middle Ground Bar by Messrs. Morris & Cummings, of New York City, under contract of May 21, 1869, whereby a channel was opened for about 2,100 feet in length, averaging about 250 feet in width, with a depth of not less than 20 feet at mean low water. Under the additional appropriation of $10,000 made by act of Congress, of July 11, 1870, this work was continued under the same contract, until the 3d of September, 1870, when the channel was completed to an average width of 300 feet, requiring the excavation of 118,415 cubic yards, whereby this appropriation was nearly exhausted.

Amount available for this work, July 1, 1870	$7,646 37
Amount appropriated by act of Congress July 11, 1870	10,000 00
Amount appropriated by act of Congress March 3, 1871	40,000 00
Total	57,646 37
Amount expended during the fiscal year ending June 30, 1871	17,997 29
Amount available July 1, 1871	39,649 08

Under instructions from the Department, proposals were invited for dredging the channel through the Middle Ground Bar to the increased width contemplated; and on the 24th of May, 1871, a contract was made for the work with Mr. George C. Fobes, of Portland, Maine, (the lowest responsible bidder,) the work to be commenced on or before the first of July, 1871, and to be completed on or before the 30th of June, 1872, for the price of 45 cents per cubic yard.

For completing the contemplated improvements of this harbor, the following estimates are submitted, viz:

1. For the completion of the breakwater, as proposed and heretofore estimated for	$40,000 00
2. Increasing the width of the new channel through the Middle Ground Bar, to an average width of 500 feet, (taking the cost of the work already done as a basis)	40,000 00
Add for contingencies, say	4,649 08
Total	84,649 08
Amount available July 1, 1871, as above	39,649 08
Additional amount required for the completion of the improvements contemplated	45,000 00

Accompanying this is a map of a recent survey of the Middle Ground Bar, showing the new channel as dredged to date.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals for same.
2. Abstract of contract for same.

Abstract of proposals received for the improvement of Portland Harbor, Maine.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1.	Dredging channel through Middle Ground Bar.	A. Boschko, Boston, Mass.	40,000 cubic yards, more or less.	60 cents per cubic yard.
2.	......do	N. C. Munson, Boston, Mass.	......do	60 cents per cubic yard; 5 cents additional for each mile hauled in excess of three miles.
3.	......do	Morris & Cumings, New York City.	......do	50 cents per cubic yard; 1 cent additional for each mile hauled in excess of three miles.
4.	......do	W. R. Stockbridge, Boston, Mass.	......do	49½ cents per cubic yard; 5 cents additional for each mile hauled in excess of three miles.
5.	......do	George C. Fobes, Portland, Me.	......do	45 cents per cubic yard.

Abstract of contracts made for the improvement of Portland Harbor, Maine.

Number for reference.	Nature of work.	Name of contractor.	Quantity.	Price.
1.	Dredging channel through Middle Ground Bar.	George C. Fobes, Portland, Me.	80,000 cubic yards, more or less.	45 cents per cubic yard.

V 13.

IMPROVEMENT OF SACO RIVER, MAINE.

The progress made in the improvement of this river up to the 30th of June, 1870, consisted in the removal of all the sunken rocks from its channel near Little Islands, (which were the most dangerous obstructions to its navigation,) and in building a stone breakwater at the mouth of the river. This breakwater had then been carried, in partial completion, for a distance of 4,200 feet outward from its shore-end to an average height of about 8½ feet above mean low water, with an average thickness of about 16 feet.

Amount available for this work July 1, 1870	$736 80
Amount appropriated therefor by act of Congress July 11, 1870	10,000 00
Amount appropriated therefor by act of Congress March 3, 1871	15,000 00
Total	25,736 80

It having been decided that the amount appropriated July 11, 1870, should be applied to increasing the height and thickness of the breakwater as then constructed, as much as the appropriation would admit of, proposals were invited for the work, and contracts were made with Mr. Hiram Hamilton, of Cape Elizabeth, Maine, and Mr. Ira Andrews, of Biddeford, Maine, for furnishing and depositing the rough stone upon the breakwater. On the 1st of October, 1870, 4,652 tons of stone had been furnished in completion of those contracts, whereby the appropriation was nearly exhausted.

The additional sum of $15,000, appropriated March 3, 1871, for this work, it was decided should be applied, so far as might be necessary, to the completion of the breakwater to the requisite height and thickness to its outer end to the extent already built. Proposals were invited for this work, and a contract was made on the 9th of May, 1871, with Messrs. Gooch & Haines, of Biddeford, Maine, for furnishing and depositing the stone required for this work, at $1 10 per ton, the contract to be completed on or before the 21st of August, 1871. On the 30th of June, 3,264$\frac{1640}{2240}$ tons of stone had been furnished under this contract, having about 4,000 tons yet to be delivered in order to complete the existing work to the extent at present contemplated.

Amount of funds available for this work during the fiscal year ending June 30, 1871, as above	$25,736 80
Amount expended during the year	13,825 88
Amount available July 1, 1871	11,910 92

The estimated amount required for completing the improvement of this river is as follows, viz:

1. For balance that will be due Messrs. Gooch & Haines on completion of their contract, say	$5,100 00
2. Dredging channel through the bar below Factory Island wharves, say 5,000 cubic yards, at 50 cents	2,500 00
3. Erecting an iron beacon on the ledge below Cow Island	1,400 00
4. For completing the piers contemplated for this river	16,000 00
Add for contingencies, say	2,910 92
Total	27,910 92

Additional amount required for completing the proposed improvements of the river	$16,000 00

This amount could be profitably expended upon the work during the next fiscal year.

Accompanying this is a map of the mouth of Saco River, showing the position of the breakwater and the present improved condition of the channel, as surveyed in June, 1871.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals for 1870.
2. Abstract of proposals for 1871.
3. Abstract of contracts for 1871.

Abstract of proposals received for the improvement of Saco River, Maine.

No. for reference.	Nature of work.	Name of bidder.	Quantity, large and small stone, more or less.	Price per ton of 2,240 pounds.
			Tons.	
1	Furnishing rough stone for breakwater.	Alfred Goodwin and Charles H. Goodwin, and Charles H. Bragdon, Biddeford, Maine.	4,000 large 2,000 small	$1 57 1 30
2	Furnishing rough stone for breakwater.	Ira Andrews, Biddeford, Maine	4,000 large 2,000 small	1 53 1 16
3	Furnishing rough stone for breakwater.	Hiram Hamilton, Cape Elizabeth, Maine.	4,000 large 2,000 small	1 40 1 20

Abstract of proposals received for the improvement of Saco River, Maine.

No. for reference.	Nature of work.	Name of bidder.	Quantity, large and small stone, more or less.	Price per ton of 2,240 pounds.
1	Furnishing rough stone for breakwater.	W. G. Gooch and C. Haines, Biddeford, Maine.	4,000 tons, more or less, large; 1,000 tons, small.	$1 10
2	Furnishing rough stone for breakwater.	Samuel B. Gilpatrick, Biddeford, Maine.	4,000 tons, large; 1,000 tons, small.	1 16
3	Furnishing rough stone for breakwater.	Chas. H. Bragdon, Biddeford, Maine.	4,000 tons, large; 1,000 tons, small.	1 18
4	Furnishing rough stone for breakwater.	Hiram Hamilton, Cape Elizabeth, Maine.	4,000 tons, large 1,000 tons, small	1 34 1 15
5	Furnishing rough stone for breakwater.	Isaac Hamilton, Cumberland, Maine.	4,000 tons, large 1,000 tons, small	1 40 1 12
6	Furnishing rough stone for breakwater.	Hugh Bowen, Portland, Maine.	4,000 tons, large 1,000 tons, small	1 49 1 18
7	Furnishing rough stone for breakwater.	Isaac Andrews, Biddeford, Maine.	4,000 tons, large 1,000 tons, small	1 55 1 20

Abstract of contracts made for the improvement of Saco River, Maine.

Number for reference.	Nature of work.	Name of contractor.	Quantity, large and small stone, more or less.	Price per ton of 2,240 pounds.
			Tons.	
1	Furnishing rough stone for breakwater.	Hiram Hamilton, Cape Elizabeth, Me	4,000 large	$1 40
2	Furnishing rough stone for breakwater.	Ira Andrews, Biddeford, Me	2,000 small	1 16
3	Furnishing rough stone for breakwater.	W. G. Gooch and Charles Haines, Biddeford, Me.	4,000 large 1,000 small	1 10 1 10

V 14.

IMPROVEMENT OF KENNEBUNK RIVER, MAINE.

The improvements of this river consist in—

1. The construction of two stone piers, in extension of those heretofore built at the mouth of the river, on each side, and in the place of the wooden catch-sands, which have been entirely washed away by violent storms.
2. The repairs of the Government wharf above the mouth of the river; and
3. The repairs of the old piers.

The appropriations made for this work are as follows, viz:

By act of Congress of July 11, 1870	$5,000 00
By act of Congress of March 3, 1871	5,000 00
Total	10,000 00

Under the appropriation of July 11, 1870, proposals were invited for building the stone pier on the eastern side of the river, and a contract was made with Messrs. Albert Blaisdell and Joseph S. Bailey of Portland, Maine, the lowest responsible bidders for the same, at $21 35 per lineal foot. On the 12th of December, 1870, they had finished 168 lineal feet in completion of their contract. Repairs were made on the eastern stone pier, as well as on the Government wharf above it; and the appropriation was nearly exhausted before the close of the season.

Under the appropriation of March 3, 1871, proposals were invited for building the stone pier on the western side of the river, and a contract was made with Mr. Charles H. Bragdon, of Biddeford, Maine, for building the same, at $18 62 per lineal foot. On the 30th of June the contractor had delivered several cargoes of stone and had made some progress otherwise on the work. On the 15th of August this contract was completed.

Amount appropriated for this work, as above.............	$10,000 00
Amount expended during the fiscal year ending June 30, 1871	4,991 16
Amount available July 1, 1871	5,008 84

This amount is believed to be sufficient for completing the contemplated improvements of this river.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals received for building eastern pier.
2. Abstract of proposals received for building western pier.
3. Abstract of contracts made for building eastern and western piers.

Abstract of proposals received for the improvement of Kennebunk River, Maine.

Number for reference.	Nature of work.	Name of bidder.	Quantity, more or less.	Price per running foot.
			Linear feet.	
1	Building an extension of eastern pier.	Elijah Buck, Saco, Me.	150	$21 00
2	Building an extension of eastern pier.	George B. Carll and Robert W. Gray, Kennebunkport, Me.	150	23 00
3	Building an extension of eastern pier.	Albert Blaisdell and Joseph S. Bailey, Portland, Me.	150	21 35
4	Building an extension of eastern pier.	Chas. H. Bragdon and Alfred Goodwin, Biddeford, Me.	150	24 62
5	Building an extension of eastern pier.	Edward Warren, Kennebunkport, Me.	150	26 00
6	Building an extension of eastern pier.	Hugh Bowen and David H. Hill, Portland, Me.	150	27 00
7	Building an extension of eastern pier.	Fitz H. Jordon, Portland, Me.	150	28 00

Abstract of proposals received for the improvement of Kennebunk River, Maine.

Number for reference.	Nature of work.	Name of bidder.	Quantity, more or less.	Price per running foot.
			Linear feet.	
1	Building an extension of western pier.	John D. Bailey, Portland, Me.	150	$21 00
2	Building an extension of western pier.	Ira Andrews, Biddeford, Me.	150	20 00
3	Building an extension of western pier.	Frank H. Blaisdell, Haverhill, Mass.	150	19 50
4	Building an extension of western pier.	Charles H. Bragdon, Biddeford, Me	150	18 62

Abstract of contracts made for the improvement of Kennebunk River, Maine.

No. for reference.	Nature of work.	Name of contractor.	Quantity.	Price per running foot.
1	Building an extension of eastern pier.	Albert Blaisdell & Joseph S. Bailey, of Portland, Maine.	150 linear feet, more or less.	$21 35
2	Building an extension of western pier.	Charles H. Bragdon, Biddeford, Maine		18 62

V 15.

IMPROVEMENT OF COCHECO RIVER, WITHIN THE TOWN OF DOVER, NEW HAMPSHIRE.

Cocheco River is navigable by vessels drawing 6 feet of water at mean low water, or 13½ feet at ordinary high water, up to the Lower Narrows, which point is about one and one-eighth mile below the dam at Dover, or three-fourths of a mile below the head of navigation. But from the Lower Narrows up to Dover the navigation is obstructed in several places, as follows, viz:

1. *Lower Narrows.*—Here it is contracted to 100 feet in width, being about one-half of its general width; and, for an extent of about 160 feet, it is obstructed by boulders and ledge-rock, upon which there are but 2 feet of water at mean low water. Two feet more depth is required at this place, to enable vessels drawing 10½ feet to pass it at mean high water.

2. *Trickey's Shoal.*—At this place the river shoals to a depth of about 2 feet, at mean low water, for an extent of about 260 feet—the bed being composed of boulders and gravel. Two feet more depth is required here also.

3. *Clement's Point*, about one-half mile above Lower Narrows. Here the river narrows to a width of 125 feet, and its bed is covered with boulders and gravel, for an extent of about 210 feet, with but 1½ feet of water upon it at mean low water. A depth of 4 feet at mean low water is required at this place also. Immediately below this point is a rock, known as Watson's Rock, which is bare at low water, and should be removed.

4. *The Upper Narrows*, generally known as the "Gulf." This place is about three-fourths of a mile above the Lower Narrows, and three-eighths of a mile below the dam. The river is here contracted, for a

short distance, to a width of but 60 feet between its rocky banks; and its channel is obstructed by ledges and boulders for a distance of about 300 feet, the shoalest part of which has but 1 foot of water upon it at mean low water. This shoal should be excavated to an average depth of 2 feet, so as to give a channel 60 feet in width, with 4 feet of water upon it at mean low water. Immediately above this point there is a shoal about 100 feet in length, with but 6 inches of water upon it at ordinary low water. This shoal is composed of coarse gravel, and should be deepened about 3½ feet, to obtain the desired depth of 4 feet at mean low water, or 10½ at mean high water—the average rise and fall of the tide being here 6½ feet.

The removal of the ledge at the "Gulf," which now acts as a dam in causing the shoal above it, may in some measure be attended with the scouring away of this shoal.

There is also, above the "Gulf," and opposite the steam-mill, another ledge of about 30 feet in extent, which should be reduced 3 feet for a width of 60 feet.

The following is an estimate of the improvements above proposed, viz:

1. Lower Narrows, excavating and removing ledge and boulders	$7,000 00
2. Trickey's Shoal, excavating 1,500 cubic yards, boulders, gravel, &c., at $1	1,500 00
3. Clement's Point, excavating 1,500 cubic yards, boulders, gravel, &c., at $1	1,500 00
4. Upper Narrows, or Gulf, excavating 1,500 cubic yards, ledge and boulders at Gulf, and above, at $20 per cubic yard	30,000 00
Excavating 1,000 cubic yards gravel, (above Gulf,) at 50 cents per cubic yard	500 00
Add for contingencies, say	4,500 00
Total	45,000 00
Amount appropriated therefor, March 3, 1871	10,000 00
Additional amount required to complete the work	35,000 00

This amount could be profitably expended upon the work during the next fiscal year.

Under the appropriation of March 3, 1871, proposals were invited for opening a channel through the Lower Narrows to a width of 75 feet, and to a depth of 4 feet at mean low water. Messrs. Morris & Cumings, of New York City, were the lowest bidders for doing this work, for $7,000 by the job, and a contract* was made with them for completing the same on or before the 31st of October, 1871.

In the latter part of June the contractors had commenced operations.

Amount appropriated for this work by act of March 3, 1871	$10,000 00
Expended up to the 30th of June, 1871	125 67
Amount available July 1, 1871	9,874 33

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* *This contract* was nearly completed on the 16th of September, 1871.

Appended hereto are the following papers, viz:

1. Abstract of proposals received.
2. Abstract of contracts made.

Abstract of proposals received for the improvement of Cocheco River, within the town of Dover, New Hampshire.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1	Excavating ledge ..	George W. Townsend, Boston, Mass.	....	$45 00 per cubic yard, measured in scows.
2	..........do	William H. Lloyd, Boston, Mass.	....	$60 00 per cubic yard.
3	..........do	Reuben Wiley, Seabrook, N. H.	Channel 40 ft. wide. Every additional ft. in width.	$8, 000 00. $200 00.
4	..........do	Morris & Cumings, New York City.	Channel 60 ft. wide. Channel 75 ft. wide.	$5, 500 00. $7, 000 00.

Abstract of contracts made for the improvement of Cocheco River, within the town of Dover, New Hampshire.

Number for reference.	Nature of work.	Name of contractor.	Quantity.	Price.
1	Excavating ledge ..	Morris & Cumings, New York City.	Channel 75 feet wide, 4 feet deep at mean low water.	$7, 000

V 16.

EXAMINATION AND SURVEY OF COCHECO RIVER, AT DOVER, NEW HAMPSHIRE.

Cocheco River is a tributary to the Piscataqua River, which it joins about four miles below Dover, New Hampshire, the distance from its junction, down the Piscataqua, to Portsmouth, New Hampshire, being about ten miles. Vessels can navigate these rivers without obstruction, with 6 feet of water at mean low water, (or about 13½ feet at mean high water,) up to the Lower Narrows, so called, which are about one and one-eighth miles below the dam at Dover, or three-fourths of a mile below the head of navigation; but from the Lower Narrows up to Dover the navigation is obstructed in several places, the locality, character, and extent of which are as follows, viz:

1. *Lower Narrows.*—At this place the river is contracted to 100 feet in width, being about one-half of its general width; and for an extent of 180 feet these narrows are obstructed by a ledge across its bed, upon which there are but 2 feet of water at mean low water. About thirty years ago this ledge was somewhat improved, under a small appropriation made therefor by Congress, but not to an extent sufficient to meet the requirements of commerce. It should be still further excavated to a width of 75 feet and for a depth of 2 feet, so as to give a depth of 4 feet at mean low water, and enable vessels drawing 10 feet to pass safely over it without danger of rubbing.

From the Lower Narrows up to Trickey's Shoals (one-third of a mile above) there are six feet of water at mean low water, without any obstructions.

2. *Trickey's Shoals.*—At this place the river shoals to a depth of but 2 feet at mean low water, and for an extent of 260 feet, the river being here 145 feet wide. The bed of the river is composed of loose rocks and gravel, which should be excavated so as to have a channel 75 feet wide and 4 feet deep at mean low water.

3. *Clement's Point*, about one-half a mile above the Lower Narrows. Here the river narrows to a width of 125 feet, and its bottom is covered with loose rocks and gravel for an extent of 210 feet, with but 1½ feet of water upon it at mean low water. This also should be excavated, so as to give a channel 75 feet in width, with 4 feet of water in it at mean low water. Immediately below this point, and near the right or south shore, there is a rock (in pieces) which is bare at very low water, and known as Watson's Rock. It is very dangerous, and should be removed.

4. The *Upper Narrows*, generally known as the *Gulf*.—This place is about three-fourths of a mile above the Lower Narrows, and three-eighths of a mile below the dam. The river is here contracted, for a short distance, to a width of but 60 feet, between rocky banks, and flows over a ledge for an extent of about 300 feet, the shoalest part of which has but one-half a foot of water upon it at ordinary low water, This ledge should be excavated to an average depth of 2 feet, so as to give a channel 60 feet in width, with 4 feet of water in it at mean low water.

Immediately above this point there is a shoal about 100 feet in length, with but 6 inches of water upon it at ordinary low water. This shoal is composed of coarse gravel, and should be deepened about 3½ feet, to obtain the desired depth of 4 feet at mean low water, or 10½ feet at mean high water, the average rise and fall of the tide being here 6½ feet.

The removal of the ledge at the Gulf, which now acts as a dam, in causing the shoal above it, may, in some measure, be attended with the scouring away of this shoal. There is also above the Gulf, and opposite the steam-mill, another ledge of about 30 feet in extent, which should be reduced 3 feet for a width of 60 feet.

With all these improvements made at and above the Lower Narrows, vessels drawing from 8 to 10 feet of water will be enabled to navigate this river from the sea up to the wharves of Dover; and considering the very great benefit that commerce will derive from it, as well as the fact that, when once done, the improvements will be permanent for all time, they cannot, in my opinion, be too strongly recommended.

The following is an estimate of the cost of the improvements above specified, viz:

1. Lower Narrows—excavating and removing 1,000 cubic yards of ledge, at $15	$15,000 00
2. Trickey's Shoal—excavating 1,500 cubic yards loose rocks, gravel, &c., at $1	1,500 00
3. Clement's Point—excavating 1,500 cubic yards loose rocks, &c., at $1	1,500 00
4. Upper Narrows, or Gulf—excavating 1,500 cubic yards of ledge at Gulf and above, at $15	22,500 00
Excavating 1,000 cubic yards gravel above Gulf, at 50 cents	500 00
Add for contingencies, say	4,000 00
Total	45,000 00

The above amount will, it is believed, be sufficient for the entire and permanent improvement of this river in the manner proposed and recommended, of which amount $25,000 could be properly expended upon it during the next fiscal year.

The following additional information is furnished, in compliance with the requirements of the law providing for the survey of this river:

Cocheco River is in the collection district of Portsmouth, New Hampshire; and the port of entry is at Dover, New Hampshire.

The nearest light-houses are, one in Portsmouth Harbor, New Hampshire, and one at Whale's Back, at the entrance to that harbor. The nearest forts are Fort Constitution and Fort McClary, both in Portsmouth Harbor.

No revenue was collected at the port of Dover for the fiscal year ending June 30, 1870, as stated by the deputy collector of that port; and this arises from the fact that vessels drawing over 6½ or 7 feet of water cannot now reach the wharves at Dover; so that, as I am informed, all the customs business is done at the Portsmouth custom-house.

For a statement of the facts tending to show to what extent the commerce of the country will be promoted by the improvements contemplated for this river, I beg leave to respectfully refer to the accompanying extract of a letter from Hon. William S. Stevens, mayor of the city of Dover, dated November 8, 1870.

DOVER, NEW HAMPSHIRE, *November* 8, 1870.

SIR: * * * * * * *

In answering your third question quite fully, I will first say that the following statements and estimates of increase are obtained from those who have been for many years engaged in business in this place, and they may be considered in every respect trustworthy.

1. *The coal business.*—There are now received at this place annually about 14,500 tons coal, all which, excepting about 700 tons, is brought up the river in gondolas from Portsmouth, and a great part of it having first been landed on the wharves there. It is believed that with vessels drawing 10 feet of water coming to our wharves, this large amount would be landed here without the expense and damage of transhipment, and the quantity used in this vicinity would be increased at once, from twenty to twenty-five thousand tons.

2. *Lumber business.*—About six small cargoes are now received, and it is believed that, with proper facilities, eighteen or twenty cargoes could come to our wharves annually.

3. *Lime, cement, and phosphates.*—We receive annually about 12,000 casks of these three articles, and the demand can easily be increased 25 or 50 per cent.

4. *Salt and molasses.*—We formerly received of these two articles about eight cargoes, and the business in them can easily be increased to three times this amount.

5. *Corn and flour.*—We ought to receive at our wharves twenty-five to thirty cargoes a year, to meet the demand for these articles in this vicinity; but we now receive, by the river, not more than five cargoes annually.

6. *The shoe business.*—The aggregate value of the shoes yearly made in this city is not less than $2,100,000, and it is believed that a large increase would take place if we could receive the materials for manufacture by water, instead of being compelled to pay railroad freight, as we now are.

7. *Other articles.*—The Cocheco Manufacturing Company use about 700 tons madder annually, and 6,000 bales cotton. The Dover Iron Foundery consumes 300 tons iron. Messrs. F. A. Sawyer & Co. use large quantities of wool and dyes in their two woolen-mills. Messrs. J. B. Folsom & Co. in manufacturing oil floor-cloths use large quantities of heavy articles; and most of all these articles in section 7 are shipped from New York to Boston, and thence brought sixty-eight miles by railroad to Dover, which expense would be saved to us could they be landed at once upon our wharves. To the above articles should be added the articles consumed by Messrs. Wiggin & Stevens in their extensive works manufacturing glue and flint paper.

Other facts might be added, but I presume those already given are sufficient. I will add only, in closing, that twenty years ago there were seven regular packets and as many transient ones running on this river, between Dover and Boston, and Dover and

New York. Our population then was about 7,000. It is now about 10,000, and the increase in business has been greater than the increase in inhabitants; and I feel warranted in saying that if the navigation of our river could be improved, so that vessels drawing 10 or 10½ feet water could come up alongside our wharves, this would speedily become a great distributing point, and we could employ two or three times as many vessels on our river as have ever been run on it before.

Yours, very respectfully,

WM. S. STEVENS,
Mayor of the City of Dover, New Hampshire.

General GEORGE THOM,
Engineer Department, U. S. Army.

V 17.

REPORT ON THE SURVEY OF FIFTEEN-MILE FALLS, NEW HAMPSHIRE.

UNITED STATES ENGINEER OFFICE,
Portland, Maine, February 11, 1871.

The act of Congress, approved July 11, 1870, making appropriations for the repair, preservation, and completion of certain public works on rivers and harbors, and for other purposes, for the fiscal year ending June 30, 1871, provides that an examination or survey, or both, be made at Fifteen-Mile Falls, New Hampshire. In compliance with instructions from the Engineer Department, dated July 21, 1870, an examination of this locality was made, with a view to ascertain the nature and extent of the improvement contemplated, and a report thereon was made to the Department on the 1st of September last, a copy of which report is hereto appended, marked A.

Fifteen-Mile Falls form a part of the Connecticut River, commencing at Dalton, New Hampshire, about two hundred and seventy-five miles above the mouth of the river, and extending down to Monroe, New Hampshire, a distance of twenty-one and a half miles. The examination made of it showed that the object of the contemplated improvement was solely to facilitate the lumber trade of the country adjacent to the river and its tributaries above the falls; and in the report thereon, it was recommended that, in case it should be deemed advisable on the part of the General Government to give further attention to its improvement, it would be necessary to have a survey made for an extent of about twenty-five miles, so as to embrace all the rapids, ledges, boulders, mill-dams, and other obstructions in the river, at the falls and in their vicinity.

Under instructions from the Department, dated the 25th of November, 1870, directing that a survey be made at the earliest practicable time, with a view to ascertaining the probable cost of improving Fifteen-Mile Falls, as suggested in the report of September 1, the survey has been completed, together with maps of the several localities surveyed, and the plans of the proposed improvements.

There were many difficulties attending this survey in mid-winter, the thermometer having for several days during its progress stood at from 10° to 30° (Fah.) below zero. The results, however, are believed to be sufficiently reliable for present purposes.

The maps and drawings are hereto appended, a list of which is as follows, viz:

3 sheets, (each 48 by 28 inches,) map of Fifteen-Mile Falls, New Hampshire.

1 sheet, map of falls and mill-dam at Guildhall, Vermont, and Northumberland, New Hampshire.

1 sheet, map head of Fifteen-Mile Falls at Sumner's, Dalton, New Hampshire.

1 sheet, map of bridge and rapids at Barnet, Vermont.

1 sheet, map of McIndoes Falls and mill-dam.

1 sheet, map of Dodge's Falls and mill-dam.

2 sheets, general plans of slips or sluice-ways proposed for passing mill-dams.

It appears that the river is used for the transportation of lumber only during the higher stages of the water, or when not below its medium height, there being in the Fifteen-Mile Falls about 3 feet of water in its lowest stages, and about 12 to 14 feet in its ordinary spring freshets. The obstructions to its transportation are confined to but few points between the mouth of Wells River and Connecticut Lake, near the source of Connecticut River. Wells River is fourteen miles below the foot of Fifteen-Mile Falls, and about one hundred miles by river below the foot of Connecticut Lake. Formerly, before railroads were in operation along and near this river, improvements were made by private corporations at the most difficult points, by removing some of the most troublesome boulders in Fifteen-Mile Falls and building slips or sluice-ways over the mill-dams at McIndoes Falls and Dodge's Falls, both situated between Fifteen-Mile Falls and Wells River. Below Wells River, rafts were run down the Connecticut to Springfield, Massachusetts, and Hartford, Connecticut, through locks which had been built by private corporations at the following points, viz: the White River Locks, at Hanover, New Hampshire; Queechy Locks, at Hartland, Vermont; Bellows Falls Locks, at Bellows Falls, Vermont; Miller's River Locks, at Montague, Massachusetts; Turner's Falls Locks, also at Montague, Massachusetts; and Hadley's Falls Locks, at Hadley Falls, Massachusetts, and some below Springfield, which were used in low stages of the river. These locks were built originally for slack-water navigation of the river by boats 60 feet in length and 13 feet in width; and it was the size of these locks which regulated the dimensions of the rafts sent from up river. These locks were built of wood, and in course of time required much repair; but instead of repairing them, their use was abandoned when the railroads along the river and its tributaries furnished facilities for the transportation of sawed lumber to the most desirable market. So that, of late years, the sawed lumber has been transported altogether by rail; that from Northumberland, New Hampshire, and above, to Portland, Maine, and that from below Northumberland, to Boston, Springfield, and other points reached by railroad.

A further investigation as to the object and desirableness of improving this river, shows that there are diverse opinions in regard to it among the leading business men of the country, who have had the most experience in its lumber trade and are most interested in it.

It is the opinion of some that the only improvement to be desired is the removal of such obstructions only as will facilitate the running of logs; and that whatever facilities may be provided for rafting sawed lumber, it is not probable that it would be transported otherwise than by railroad, while others express the opinion that the lumber trade of the river would be greatly benefited not only by removing obstructions to the running of logs, but also by making the proposed improvements for the rafting of sawed lumber, whereby the lumber trade would be much increased, owing to a diminished cost of transportation as compared with the present railroad prices, and a saving in freight realized, of not less, probably, than from fifty to seventy-five thousand dollars a year; this estimate being based on the fact that there would be a saving of not less than $2 per thousand feet of lumber on the present railroad prices, and on the fact that the quantity of lumber now cut on the river and its tributaries above Fifteen-Mile Falls is about 50,000,000 feet, and would probably be increased to 75,000,000 a year, of which one-half would probably be transported in rafts to markets on the river below. This increase would necessarily depend also upon the repair and reopening for rafting business of the several locks below Wells River; whereas the running of logs would be independent of those locks. The lumber trade would doubtless be much increased by either method of improvement, and separate estimates are herein submitted for the cost of each, applied only to localities above Wells River.

The following are the principal difficulties, and the points where they occur, named in the order of their locality, viz:

The mill-dam at Northumberland, New Hampshire, opposite Guildhall, Vermont.—This place is about fourteen miles above the head of Fifteen-Mile Falls. The river here, about 300 feet wide, is obstructed by a crib-work dam, which extends up the river in zigzag lines nearly to the bridge; the dam being 2 feet high at its upper extremity and 6 feet at its lower extremity, as represented on the accompanying drawing. This dam is so arranged in order to prevent the overflow of lands on low banks above. As built, it offers no obstruction to the running of logs, when the river is at a suitable height for that business; but for the rafting of sawed lumber, it is desirable to have a slip or sluice-way near the saw-mill at the western extremity of the dam. A sluice-way constructed of timber, on the plan described in the accompanying drawing, would, it is believed, meet the object in view. In order to prevent any unnecessary waste of water at this dam, it is proposed to have a gate constructed as in the accompanying drawing, or else to have planks let into grooves at the head of the sluice-way, the planks being removable at pleasure.

2. *Fifteen-Mile Falls.*—The river at these falls averages about 250 feet in width, and is obstructed with numerous boulders, especially at the head of the falls near Sumner's, and in the three-mile rapids or horse-race near the foot. These boulders vary in size from 2 to 10 feet in diameter; but it is only the largest of these, varying from 5 to 10 feet in diameter, that it is particularly desirable to have removed. In order to open a channel of the desired width, say 150 feet, it would require the removal of from three hundred to four hundred of these boulders. This improvement is required as well for the running of logs as for the rafting of sawed lumber.

Between the foot of the falls and the mouth of Passumpsic River, (which is about one mile below the falls,) the river widens out and contains several islands and channels, of which the main channel, after making a sharp bend, follows the right bank of the river. In the running of logs, difficulties are here met with, from their liability to leave the main channel for a more direct course, and thereby lodge upon the numerous islands and flats, where they would have to remain for another rise of the river, or else would require much labor to be removed into the proper channel. It is believed that these difficulties could be obviated by the construction of a crib-work, so arranged as to divert all the logs and rafts into the main channel.

3. *Rapids at the bridge at Monroe, New Hampshire, opposite Barnet, Vermont.*—These rapids are about four miles below the foot of Fifteen-Mile Falls, or ten miles above Wells River Junction. At this place there is a narrow channel which follows the south or left shore of the river, as shown in the accompanying sketch, through which rafts were

formerly run. The fall here is but ten inches, and there do not appear to be any difficulties requiring attention.

4. *Ledge about one mile above McIndoes Falls, or five miles below the foot of Fifteen-Mile Falls.*—This ledge is about in the middle of the river, and is so situated as to force rafts down its eastern channel upon a rocky point in the bend below. With a view to facilitating the rafting of lumber, it is desirable that this ledge should be removed, so that rafts may be run clear of the rocky point below. The extent of this ledge, which it is proposed to remove, is 96 feet in length by 17 feet in width, and about one yard in depth—about 180 cubic yards.

5. *McIndoes Falls and mill-dam, eight miles above Wells River Junction.*—Here the river widens to a distance of about 500 feet at the dam. This dam is of wooden crib-work, and is in good condition. It rests on a slate ledge, the strata of which are nearly vertical, and at right angles nearly to the river. The fall of the water is 14.8 feet, and affords water-power for the most extensive saw-mills on the river. About midway of the dam (as seen on the accompanying drawing) there is a ledge, through which a sluice-way was once cut, some of the wood-work of which still remains. This sluice-way is about 100 feet in length by 25 feet in width.

Logs are now run over this dam without difficulty; but for facilitating the rafting of sawed lumber, it is desirable to have the old sluice-way excavated to a sufficient depth, and a new one constructed on the plan herewith submitted. The dimensions of these sluice-ways are regulated, in all cases, by the size of the locks on the lower part of the Connecticut River, heretofore referred to, and by the fact that about 18 inches of water is required to float the rafts.

The quantity of rock excavation that would be required for building this sluice-way is 230 cubic yards.

6. *Dodge's Falls and Mill-dam, four miles above Wells River Junction.*—These falls are about 350 feet wide at the mill-dam, with a fall of 13.1 feet. The dam is built of crib-work, ballasted with stone; and in its present condition it offers no obstruction to the running of logs over it.

For the rafting of sawed lumber, a slip or sluice-way was built several years ago, near the eastern end of the dam, but it no longer exists. The improvement now desired at this place, for facilitating the rafting of sawed lumber, is a slip or sluice-way, built at the site of the old sluice-way, as shown on the accompanying drawing; the plan and dimensions of the sluice-way to be the same as that designated for McIndoes Falls. The following estimates are submitted for the improvements proposed as above, viz:

1. *For improving the river for the running of logs only.*

1. Removing boulders in Fifteen-Mile Falls, say	$10,000 00
2. Crib-work near foot of Fifteen-Mile Falls	6,000 00
3. Removing ledge five miles below Fifteen-Mile Falls	500 00
4. Engineering and contingencies	1,500 00
Total	18,000 00

2. *For improving the river for rafting sawed lumber.*

1. Sluice-way (60 feet long) at Northumberland Falls	$1,000 00
2. Removing boulders in Fifteen-Mile Falls, as above	10,000 00

3. Crib-work near foot of Fifteen-Mile Falls, as above	$6,000 00
4. Removing ledge five miles below Fifteen-Mile Falls, as above	500 00
5. Sluice-way (110 feet long) at McIndoes Falls, including 230 cubic yards of rock excavation	2,000 00
6. Sluice-way (110 feet long) at Dodge's Falls, including substructure of crib-work	3,000 00
7. Engineering and contingencies	2,500 00
Total	25,000 00

From the foregoing estimates it appears that, for the improvement of Connecticut River at Fifteen-Mile Falls, and other localities in their vicinity, above Wells River Junction, there will be required the following sums, viz: 1. For its improvement for the running of logs only, $18,000. 2. For its improvement both for running of rafts of sawed lumber and the running of logs, $25,000.

This second estimate does not include the cost of any of the improvements below Wells River, which are indispensable for carrying out the proposed system of improvements. Moreover, the subject of the maintenance of these works is also to be considered, as well as the right of the United States Government to interfere in any manner with the mill-dams belonging to private parties, as well as the control and ownership of the proposed improvements when completed; objections, however, which do not apply to the proposed improvements for the running of logs only, owing to the character and locality of such improvements.

In consideration of the above facts, it is respectfully recommended that, whatever attention the United States Government may see fit to bestow toward the improvement of this river at Fifteen-Mile Falls and its vicinity, for the purpose of facilitating the lumber trade upon it, it should, for the present, be applied solely with a view to the running of logs.

The amount estimated for this is, as above, $18,000; which, it is believed, could be profitably expended upon the work during the next fiscal year.

Respectfully submitted.

GEO. THOM,

Lieutenant Colonel of Engineers, Bvt. Brig. Gen., U. S. A.

A.

Report on the examination of Fifteen-Mile Falls, New Hampshire, by Lieutenant Colonel George Thom, Corps of Engineers.

Fifteen-Mile Falls form a part of the Connecticut River, commencing at Dalton, New Hampshire, (about two hundred and seventy-five miles above the mouth of the river,) and extending down to Monroe, New Hampshire, a distance of about twenty-two miles.

An examination of this locality shows that the desired improvement consists in the removal of some ledges and a vast number of boulders which lie in the bed of the river, (bare at low water,) more or less scattered throughout the whole extent of the falls, and in the construction of locks and dams around several private mill-dams and elsewhere on the river, so as to facilitate the lumber trade of the country adjacent to the river and its tributaries above, and for no other purpose. It is only during the high stages of the water that it is contemplated to make use of the river for this purpose, and in these stages I am informed there are no serious obstacles to the running of logs over the falls and dams in their present condition; but that in running rafts of sawed lumber, which can only be done in high stages of the river, they are more or less liable to injury, which fact, as well as the facilities offered at all seasons of the year by the neighboring railroads for conveying lumber to any point desired, near or distant from the river, has caused the rafting of the lumber to be in a great measure discontinued. At present there are three railroads which strike and cross the river at and above the falls, viz: the Portland and Montreal Railroad crosses it about twenty-five miles above the falls; the Boston, Concord and Montreal Railroad strikes the river on its eastern bank at Dalton, at the head of the falls, and connects with the Connecticut River and other railroads at Wells River Junction, forty miles below Dalton; and the Connecticut and Passumpsic River Railroad strikes it on its west bank at Barnet, Vermont, near the foot of the falls, and connects with other railroads which follow the banks of the river all the way down to Hartford, Connecticut, a distance of about two hundred miles. The greater part of the lumber which is sawed above the falls is now carried by these railroads to various parts of the country more or less distant from the river, and in all times of the year, but it is stated by parties who are fully acquainted with the subject, that if the desired improvements were made for facilitating it, it would be rafted down the river in high water at a lower cost than it can be transported by rail, and would create a large lumber trade with Canada and other places situated on and near the head-waters of the Connecticut.

The objects which are deemed particularly important to be attended to in order to effect this improvement, are the following, viz:

1. The removal to a width of, say, 200 feet, of the numerous boulders which lie in the bed of the river, between the head and foot of the falls.
2. A lock and dam at the rapids about five miles above Barnet, Vermont, where the river is very narrow, rapid, rough, and rocky; also a blasting out of the ledges at this point.
3. A lock around the mill-dam at Barnet, Vermont, and another around the mill-dam at Dodge's Falls, five miles below Barnet.

In addition to these, there are several other dams in the river above and below the falls, including the dam at Guildhall, (fourteen miles above the head of the falls,) to which it is as important to give attention as to any of those at and near the falls, in order to increase the desired facilities for lumbering.

At several of these dams, private parties have hitherto constructed locks, from which they received toll for the facilities offered by them. But these have been abandoned of late, especially since the opening of the various railroads, which have in a great measure monopolized the transportation of the lumber.

Such is the condition of affairs, so far as I have been able to ascertain from some of the most intelligent and influential men who are interested in this matter.

The question now arises, what importance is to be attached to these improvements. If it should be deemed advisable to apply any portion of the $40,000 which was appropriated "for the improvement of Connecticut River," by act of July 11, 1870, to the improvement of the river, in the manner and for the purposes suggested, or to make an estimate of the amount necessary therefor, with a view to a future appropriation, it would, in my opinion, be necessary to have a careful survey of it made for an extent of about twenty-five miles, so as to embrace all the rapids, ledges, boulders, mill-dams, and other obstructions in the river, at the falls and in their vicinity. In consideration of the object contemplated in the proposed survey of this river, I have not submitted with this report as full statements of all the existing facts tending to show to what extent the general commerce and navigation interests of the United States will be subserved by the improvement of the river in the manner suggested. This information will be furnished hereafter, if desired, as an appendix to this report, or in connection with the report on the survey of the river, should one be made.

Respectfully submitted.

GEORGE THOM,
Lieutenant Colonel of Engineers.

UNITED STATES ENGINEER OFFICE,
Portland, Maine, September 1, 1870.

V 18.

IMPROVEMENT OF MERRIMACK RIVER, MASSACHUSETTS.

The works for the improvement of this river were under Brevet Major General John G. Foster, lieutenant colonel of engineers, until the 25th of May, 1871, when they were transferred to me.

The improvements originally contemplated were as follows, viz:

1. The removal of obstructions at Upper and Lower Falls, above Haverhill, Massachusetts.

2. The removal of Gangeway Rocks, in Newburyport Harbor, Massachusetts.
3. The removal of "The Boilers," near the city wharves, at Newburyport; and,
4. The removal of the wreck of the schooner Globe, a coal vessel sunk at the mouth of the river, near Newburyport light.

By act of Congress of July 11, 1870, there was appropriated therefor	$25,000 00
And by act of March 3, 1871	25,000 00
Total	50,000 00
Amount expended during the fiscal year ending June 30, 1871	24,996 34
Amount available July 1, 1871	25,003 66

The following is a copy of General Foster's report, January 30, 1871, of the operations to that date in Merrimac River, near its mouth, and at the Lower Falls:

NEWBURYPORT HARBOR, MOUTH OF MERRIMAC RIVER.

Operations were commenced at Newburyport upon the wreck of the schooner Globe, sunk near the mouth of the river. A full report of the destruction of the wreck and its removal was forwarded by me on the 28th of September last.

Immediately after this preparations were made for the removal, by blasting, of Gangeway Rock, a most dangerous rock lying just on the borders of the channel, near the south pier. The work was vigorously pushed by the contractor until it was completely removed to the depth of 9½ feet, which was the depth of the channel at that point.

After this, work was commenced upon north Gangeway Rock, lying on the north side of the channel, opposite the main Gangeway Rock, and continued until the appropriation was exhausted.

Only a few days' work was lost during the season, which was caused by the extreme muddy state of the water consequent upon severe rain-storms, when the divers were unable to see where to place the charges of powder, or sling the rock already broken.

The result of this season's work was very satisfactory, the main Gangeway Rock being completely broken up and removed, and a good commencement made on the North Gangeway. Some of the larger pieces blasted off from the latter still remain upon the bottom, and will be removed as soon as another appropriation becomes available.

The rock is coarse granite, and splits very easily, so much so that it was found more desirable to use common powder than dualin, the latter breaking or smashing the rock into too small pieces, while the former produced much larger fragments, which were easily slung by the divers, and thus removed more economically.

About 600 tons of rock were actually hoisted on the deck of the vessel and deposited on the shore.

LOWER FALLS, ABOVE HAVERHILL, MASSACHUSETTS.

Some difficulty was experienced at first in finding parties who were willing to make an estimate or bid for the work, in consequence of the exceptional condition of the river-bottom at that place. As, however, Mr. Boschké proposed to do the work at the price estimated for by me in my letter of the 16th of August, 1869, the contract was (with the consent of the Chief of Engineers) given to him.

Work was continued, with satisfactory success, until about two-thirds of the whole amount of excavation of the channel at the Lower Falls was removed, when, the appropriation becoming exhausted, the work was stopped.

From the experience gained during the continuance of operations at this point, I am satisfied that the work can be continued at a much lower rate than that paid for the past excavations, which were rendered more expensive by the necessity of the construction of a new machine especially adapted to the work.

The appropriation of July 11, 1870, was nearly all exhausted by the operations carried on by General Foster, as above reported, up to January, 1871.

The act of March 3, 1871, requires the amount appropriated thereby to be applied to the river *above* Haverhill. Proposals were therefore invited for dredging a channel through the Lower and Upper Falls, to a width of 60 feet and depth of 4 feet at mean low water; and on the 31st of May, 1871, a contract was made with Mr. W. S. Fretch, of Boston, Massachusetts, (the lowest of the bidders,) for doing the work at $10 per cubic yard, the same to be commenced on or before the 1st of July, and to be completed (to the extent of the funds available) on or before the 31st of December, 1871. No work was done under this contract during the remainder of the fiscal year.

The following is an amended estimate of the cost of the improvements remaining to be done on the 30th of June, 1871, based, in part, upon a re-survey of the Lower Falls and of the chute next above, viz:

1. Excavation and removal of 4,500 cubic yards of material in Lower Falls, at $10	$45,000 00
2. Excavation and removal in Upper Falls, say 8,500 cubic yards, at $10	85,000 00
3. Completing the removal of the north Gangeway Rock, in Newburyport Harbor, 700 cubic yards, at $20	14,000 00
4. Removing the boilers near the city wharves in Newburyport Harbor, say	6,000 00
Adding for contingencies	15,003 66
Total	165,003 66
Amount available July 1, 1871, as above	25,003 66
Additional amount required for the completion of all the proposed improvements	140,000 00

The increase of the foregoing estimates at the Lower and Upper Falls arises chiefly from the fact that the excavation of the bar at the Lower Falls requires the excavation to be correspondingly increased at the Upper Falls, where there is no tide-water to overcome the effect of the removal of the lower bar.

After opening a cut through the bar at the Lower Falls, a new bar with a strong current over it was created a short distance above, which will require excavation not estimated for in previous reports, but is included in the estimate submitted above.

Of the works estimated for, as above, those for which an appropriation is particularly recommended are the removal of the sunken rocks in the harbor of Newburyport, Massachusetts, the estimated cost of which is	$20,000 00
And the completion of the channel through the Lower Falls and the chute next above, requiring the additional sum of	20,000 00
Adding for contingencies, say	5,000 00
Total	45,000 00

Which amount could be profitably expended during the next fiscal year.

The cost attending the excavation of a channel through the Upper Falls, as heretofore contemplated, is so great, and the effect that would thereby be produced upon the channel above, make it, in my opinion, a matter at least of doubt whether an additional appropriation should be applied to this purpose. It would appear that the most practicable method of rendering this river navigable at and above the falls is by creating slack-water by a lock and dam at the Upper Falls, but so built (if practicable) as not to injure the mill privileges at Lawrence a few miles above. To determine the feasibleness of this plan and to estimate its cost, would require additional surveys to be made for that purpose.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals received.
2. Abstract of contracts.

Abstract of proposals received for the improvement of Merrimack River, Massachusetts in response to advertisement dated April 14, 1871.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1	Excavating a channel through Upper and Lower Falls.	A. Boschkó, Boston, Mass ...	Channel 4 ft. deep, 60 feet wide.	$15 00 per cubic yard, measured in scows.
2	..........do	Emory R. Seward, Albany, N. Y.	..........do	14 00 per cubic yard.
3	..........do	W. S. Fretch, Boston, Mass..	..........do	10 00 per cubic yard.

Abstract of contracts made for the improvement of Merrimack River, Massachusetts, during the fiscal year ending June 30, 1871.

Number for reference.	Nature of work.	Name of contractor.	Quantity.	Price.
1	Excavating channel.	Albert Boschkó, Boston, Mass.	Channel, 1870	$25 00 per cubic yard.
2	..........do	W. S. Fretch, Boston, Mass..	Channel, 1871	10 00 per cubic yard.

V 19.

BOSTON, MASSACHUSETTS, *January* 20, 1871.

GENERAL: I have the honor to report that, in obedience to the directions in your letter of the 23d July, 1870, I have made an examination of Gloucester Harbor, Massachusetts, with a view to its improvement, and have caused special surveys to be made of Dog Bar and Round Rock Shoal, situated at the entrance to the harbor, and also of several rocks in the upper harbor that are obstacles to navigation.

I herewith present the results, comprised in two sheets of drawings, accompanied by a detailed description and estimates.

Sheet No. 1 represents the survey of Dog Bar and Round Rock Shoal, with the line of location and cross-sections of a proposed breakwater, to form a harbor of refuge in the lower harbor. The side sketch upon this sheet is copied in outline from the Coast Survey chart, and shows the relative positions of this bar, shoal, and proposed breakwater to other points in the outer and inner harbor.

Sheet No. 2, the outlines and soundings of which are copied from the harbor commissioner's map of 1865, shows the location of the principal rocks in the inner harbor, the removal of which is desired. Upon the margin of this sheet is shown on a larger scale the elevations, plans, and sections of these rocks.

The removal of these rocks appears to be very desirable, as they interfere very much with the free movement of vessels in the upper harbor, which has a small area, and is at times very much crowded.

The large number of vessels from this port engaged in the fisheries, and in carrying salt and ship-stores, which have to come to the wharves to receive supplies or cargoes, or deliver freight, which number is increasing yearly, renders it important to the shipping interests of the port that these rocks be removed.

The cost of their removal will not, in my opinion, exceed $12 per cubic yard, as they are situated in the well-sheltered portion of the harbor.

The cost of their removal, at the rate of $12 per cubic yard, will be as follows:

Babson's Ledge, 670 cubic yards, at $12	$8,040 00
Clam Rock, 30 cubic yards, at $12	360 00
Pinnacle Rock, 78½ cubic yards, at $12	942 00
Rock off J. Friend's wharf, 22 cubic yards, at $12	264 00
Rock off Pew's wharf, 3 cubic yards, at $12	36 00
Total cost, 803.5 cubic yards, at $12	9,642 00
Contingencies, 10 per cent	964 20
Total cost	10,606 20

BREAKWATER AT EASTERN POINT.

The examination and survey at Dog Bar and Round Rock Shoal shows the practicability of the construction of a breakwater, connecting them with the Point, at a comparatively moderate cost, considering its length and the extent of good anchorage ground that it will protect from the swell of the sea.

I have located its axis upon the summit of the ridge of Dog Bar, except at the eastern end, where I have directed it to the point within Light-House Point, for the double reason that the foot of its outer slope will be better protected, and that the material for the enrockment or riprap of the breakwater, located in the quarry upon that point, and also in the hill upon which stands the fort, constructed in the last war, may be reached by the shortest line.

The breakwater ought, when completed, to extend to Round Rock Shoal, for the sea in rough southerly weather breaks entirely across from it to the end of Dog Bar, although the depth of water at some points between is 27 feet at low tide.

When thus completed, this breakwater will render nearly the whole of the lower harbor a safe anchorage for vessels, and its value, for vessels seeking it for refuge in storms, will be very great. By the letter of Major F. T. Babson, collector, which is inclosed, it will be seen that since 1839, in this exposed portion of the harbor, 50 vessels have been totally wrecked, 10 driven on shore, 10 driven out to sea, (two of which had to be abandoned,) 40 dismasted, and 20 lives lost. This strongly illustrates the exposed character of this portion of the harbor. The losses fall principally upon the coasting vessels which seek this harbor for safety in storms.

Its importance as a harbor of refuge is second to none upon this coast, and is equalled only by Portland and Provincetown.

Standing prominently out to sea, Cape Ann is one of the most marked of the great features of the coast; and this harbor, situated just within its outer point, offers great facilities for shelter in storms, and for ingress and egress in all directions of the wind.

In former times the upper harbor afforded all the space required for the local trade, as well as for vessels seeking shelter; but the fisheries and coasting trade have simply outgrown this space, which now barely affords room for the local trade, crowding the coasters into the lower harbor. Hence the large number of losses, during late years, in this part of the harbor.

Although the breakwater will not afford entire shelter from the wind, yet it will shut out the heavy swell which sometimes sets into the harbor from the southward, causing great damage, and even extending its injuries to vessels lying at the wharves in the upper harbor.

After a careful consideration of the whole subject, I am strongly impressed with the importance and value of this breakwater as providing a much-needed harbor of refuge for the increasing coasting trade.

It is estimated that 7,000 vessels sought the shelter of this harbor during the year 1870; 3,390 of these were boarded by the revenue boat.

The value of the commerce to be benefited by the proposed work.

The collector of the port states that in the year 1870 there were—

	Tons.
226 vessels entered, carrying	24, 528
155 vessels cleared, carrying	19, 377

Tonnage of the district.

570 vessels	30, 279. 86
Value of imports	$74, 013
Value of exports	8, 383
Value of produce of fisheries	3, 724, 500
Duties assessed in the year	66, 649

CONSTRUCTION OF BREAKWATER.

I propose to construct the portion up to low water, of rough stone or riprap, by building out from the shore end, and dumping the stone from cars, running on a track connecting with the quarries on shore. After this enrockment shall have assumed the form and slope given by the waves, the top of the riprap should be leveled off with larger blocks compactly and carefully laid.

Upon this the superstructure is to be built, consisting of a wall, faced on each side with stone, arranged as headers and stretchers, with dove-tailed joints, and filled in between with compact concrete. This solid construction is necessary, in order to obtain the strength required to resist the heavy swells and seas during southerly gales, and also to be enduring. It has a greater strength of construction than is given to the sea-walls in this harbor, as it is faced both on the front and back, like the face of a sea-wall, and is filled in between the faces with compact concrete; such a wall will stand forever. I have carried it up only about 11 feet above high water for economy's sake. It would afford a better shelter from the wind if it were higher, but I think this height will be sufficient.

The seas, in very rough weather, will probably break over the wall, but this will not appreciably disturb the tranquillity of the roadstead; the heavy swells of the sea, which do the most damage, will be effectually shut out by the wall.

The general outline of the section of the face and back will be parabolic, similar to the curve of cross-section of the natural beaches found upon this coast.

The general width at top is 10 feet. The width at bottom depends upon the depth, the inclination of the face under water being assumed as about 30°.

The channel end of the breakwater should be enlarged to form a base for a harbor light or beacon. The expense of this enlargement will probably be covered by the allowance made for contingencies.

ESTIMATED COST OF CONSTRUCTION OF BREAKWATER.

I have estimated that the stone for the riprap portion of the breakwater may be deposited for 75 cents per ton, as persons have assured me of their readiness to take the contract at that price.

The leveling off the top of the riprap, and laying large blocks for foundation of superstructure, will cost (I have estimated) $1 25 per ton.

The cost of the superstructure, for facing, concrete filling, and coping, is estimated on the basis of the actual cost of similar work on sea-walls in this harbor. The cost in reality may not be as great, because the locality at Gloucester is near the quarries from which the stone must be obtained.

Cost of riprap up to high water:	
232,994 tons of stone, at 75 cents	$174,745 50
Top of riprap, 24,362 tons, at $1 25	30,452 50
Superstructure:	
61,584 superficial feet of granite for facing, at $1.967	121,138 80
3,831 running feet of coping-stone, at $13 50	51,718 75
Concrete filling, 8,373 cubic yards, at $8 50	71,170 50
Cost of breakwater	449,226 05
Add 10 per cent. for contingencies	44,922 60
Total cost	494,148 65

In connection with this subject, and in obedience to circular of May 27, 1869, I desire to call attention to the question of the real estate owned by the United States in the town of Gloucester.

After such examination as I have been able to make, I am satisfied that, in addition to the ground actually covered by the old fort on Fort Point, the whole of that point, and the adjacent neck of land, properly belongs to the United States.

The heirs of George H. Rogers, and others, claim, as reported in my letter of November 14, 1870, all the land except what is covered by the walls of the fort. It is believed that this claim is entirely without foundation.

I inclose a copy of the extract from the records of the original grant of the land to the United States, by the town of Gloucester, as furnished to me by Major Babson, collector.

It will be seen that the town ceded to the United States "all the land the property of the town, on Watch-House Neck, so called," "for the purpose of erecting a fortification thereon."

The grant, therefore, now holds good, the only question being as to the extent or limits of the "land the property of the town," at the time of the grant.

This can be settled by legal investigation. As this land can be of no further use for the purpose of a fortification, being within the limits of the built-up portion of the town, it is recommended that it be sold, and that the proceeds be applied to the improvement of the harbor.

It is also recommended that the old ordnance store-house on High street, belonging to the United States, be also sold, and the proceeds applied to the same object.

The following papers are inclosed:

1. Report of H. F. Bothfeld, civil assistant, January 13, 1871.
2. Letter of Major F. T. Babson, collector, November 26, 1870, inclosing statistics, &c.
3. Letter of Major Babson, of September 1, 1870, inclosing copy of records of grant of Fort Hill to the United States by the town of Gloucester, at the annual town meeting held May 12, 1794.

I have the honor to be, very respectfully, your obedient servant,

J. G. FOSTER,
Lieutenant Colonel Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

BOSTON, *January* 13, 1871.

COLONEL: I have the honor to lay herewith before you two sets of drawings, originals and copies, embodying the result of recent surveys of Gloucester Harbor, Massachusetts, made under your directions, in part by Mr. A. Boschké, civil engineer, and myself, with a view of delineating a system of improvements for said harbor.

On sheet No. 1, all the improvements projected are enumerated, and marked on the sketch of the harbor by red letters, A, B, C, D, E, and F; this sketch was copied for this purpose, in its general outlines, from the Coast Survey map published in 1855. Of these improvements the by far most extensive and important one, the proposed construction of a breakwater on the shoals at the entrance of the harbor, west of Eastern Point, is illustrated, as to location and manner of construction, in a special sketch, appearing on the same sheet, the data for which were obtained from a survey made in August, 1870, by Mr. A. Boschké, civil engineer, and in cross-sections and length profile through axis of breakwater. This breakwater is to consist, in the main, of two parts, viz: the under and upper structure.

The *under structure*, riprap work, of a total length of 3,870 feet, has a varying cross-section of from 50 to 100 feet at the base, by a constant width on top of 20 feet, and a height of from 11 to 35 feet, measured on the axis. The parabolic slopes form an angle of about 30° to 35° with the bottom of the bar; the top is to be laid in the plane of mean high water; in the upper part of the structure, for about 4 feet in height, large sized stones will be compactly and carefully laid so as to cover joints, the largest stones to be used as headers on the faces of the slopes, so as to underrun, for several feet, the first course of the upper structure, the uppermost layer of stones to be adjusted to a general, level, and the interstices between the stones to be filled with spalls.

Upper structure.—An even bed is prepared for it by leveling the upper surface of the riprap with cement mortar. The structure itself consists of four facing-courses, A, on both sides and ends, of cut-granite, of 2 feet rise each; the stones, in each course, are to be laid alternately as headers and stretchers, with dovetailed joints; beds and builds to be rough-hammered straight, and joints not to average more than ⅜ of an inch in thickness. The filling, B, between the courses of concrete well-rammed home, and the heavy capping, C, of 2 feet 6 inches rise, of through stones 10 feet deep, by an average face-measure of 4 feet, beds to be rough-hammered straight, top to be brought to a general level, but left in the rough; joints to be of the dovetailed pattern for 2 feet back from each face. The subjoined estimate of cost could possibly be placed lower on account of the great facilities the locality furnishes for obtaining all the materials, with, perhaps, the exception of cement.

Estimated cost of Gloucester breakwater.

Under structure:		
Riprap work up to reference (4 feet 9 inches) above mean low water and junction with shore and aprons, viz: 232,994 tons of stone at 75 cents	$174,745 50	
Upper layers of riprap work, from reference (4 feet 9 inches to 8 feet 9 inches), above mean low water, viz: 24,362 tons, at $1 25	30,452 50	
Total for under structure		$205,198 00
Upper structure:		
61,584 superficial feet of cut-granite facing, at $1 50	$92,376 00	
Setting facing, 61,534 superficial feet, at 45 cents	27,712 80	
Cement mortar, viz: 383 barrels of cement, at $2 40	919 20	
1,308 bushels of sand, at 10 cents	130 80	
		$121,138 80
3,831 running feet of coping, at $11 25	$45,098 75	
Setting coping, 3,831 running feet, at $1 50	5,746 50	
Cement mortars, viz: cement, 319½ barrels, at $2 40	766 20	
Sand, 1,073 bushels, at 10 cents	107 30	
		$51,718 75
Concrete filling in wall, viz: 8,373 cubic yards, at $8 50		$71,170 50
Total for upper structure		244,028 05
Total estimate cost of breakwater		449,226 05
Add 10 per cent on estimated cost for contingencies		44,922 60
Grand total of estimated cost		494,148 65

The amount of contingencies has been assumed somewhat high, on account of the probability of the work of construction having to be carried on through a period of three to five years, or even longer, and for the reason that a pier-head for a beacon-light, at the westerly end of the breakwater, may have to be included in its construction.

On sheet No. 2 the upper harbor of Gloucester is shown, as surveyed under the directions of the State commissioners of Massachusetts, by Mr. A. Boschké, civil engineer. Some slight alterations thereon have been made by me to make the map correspond with the actual construction of some of the wharves. The locations of the rocks, as determined by me, with the assistance of a diver, in November last, have been marked on the plan with the red letters A, B, C, D, E, and special sketches and notes have been added descriptive of the character and size of the rocks, &c.

The survey disclosed the fact that some of the rocks could hardly be called obstructions to navigation; the rock, or rather small head of granite ledge, off J. Friend's wharf, at D on sketch, and the small boulder off Pew's wharf, come under this description.

All the rocks offer comparatively but little difficulty for removal, being either the solid heads cropping out from granite ledges of coarse texture, or detached granite boulders of greater or smaller size, all situated in sheltered parts of the harbor, where currents and winds are of little account.

I have no doubt that all the larger boulders can be easily broken up to suitable size for removal, by charges of dualin being fired from their tops; one or two charges, fired from a drill-hole about 8 feet in depth in the center of Clam Rock, and a few small charges from one or two drill-holes of lesser depth in the small granite ridge off J. Friend's wharf, will certainly dispose of these obstructions, if heavy charges of dualin placed on top will not do it.

I shall now, in a few words, give whatever information has been derived from my special survey, and add estimated cost for the removal of each rock.

Babson's Ledge (at A on sketch) is situated at the head of the lower harbor, southerly of Fort Point, and about 300 yards from it, Ten-Pound Island light bearing south 3° 12′ west from its central part.

Beacon, on southwest spit of Rocky Neck, bearing east 10° 30′ south from its central part.

Southeast corner of Pavilion Hotel bearing north 1° 39′ east from its central part.

It approaches with its shallowest part nearest to the channel; its extreme length between the 18-foot curves is 260 feet; its greatest width 178 feet, with an area inside the 18-foot curve of 3,000 square yards. The ledge has, so far as my survey disclosed it, not less than 18 feet of water over it at mean low water, the obstruction for vessels drawing 13 feet or more being caused by the many boulders of granite with which it is thickly covered. These boulders are of all possible sizes, from small shingle, wedged in between the boulders, up to pieces of twenty and more tons, some of which have less than 13 feet over them at mean low water. The sea-weed attached to the larger boulders and higher parts of the ledge interfered much with making a careful survey, as the diver had great difficulty to get a footing between the slippery boulders which were covered and surrounded with it. From the soundings taken, and the description given to me by the diver, who made several descents to the ledge on different parts, I find that there are about 670 cubic yards of boulders to be removed in order to obtain about 18 feet over the solid ledge at mean low water. The surrounding bottom of the ledge averages about 19 feet at mean low water, except south, southeast, and east of it, where it slopes rapidly down to the deep water of the channel.

The ledge, being but poorly marked by a spar-buoy over its middle, is considered, on account of its extent, a considerable inpediment and danger to vessels drawing 13 feet and more—as, for instance, the vessels bringing salt from Europe or elsewhere, in particular when tacking against head-winds.

The estimated amount of rock to be removed is 1,500 tons. After breaking up the larger boulders, by surface charges with dualin, it will not be difficult either to hoist the pieces by shackling them, or, to save the expense of a diver and dispatch work, to grapple for them with a clam-shell dredge.

Clam Rock, (at B on sketch,) embedded in mud, is a round clam-shell shaped head cropping out from a solid ledge of coarse dark-colored granite, situated at the entrance into Harbor Cove, right in the way of the many vessels going to their berths at the well-sheltered wharves. Its length is 15 feet, average width 11½ feet. It has one foot over it at mean low water, and rises 8 feet above the bottom surrounding it. It contains 30 cubic yards above the 9-foot water-line, or about 67 tons. The *modus operandi* for its removal may corrrespond with that mentioned above; or, to make sure at once of success, a drill-hole 8 feet in depth may be driven, and charges fired from it.

Pinnacle Rock, (at C on sketch.) A group of granite boulders, situated south-southeast of D. Parkhurst's wharf, and about 170 feet from the middle of its channel-face, consisting of Pinnacle Rock proper and a group of smaller boulders west of it.

Pinnacle Rock proper, a large boulder, conforming somewhat in shape with its name, has 8.3 feet over it at mean low water, and rises 8 feet 4 inches above the surrounding bottom of soft mud, into which it has sunk from 1 to 1½ feet. It measures 16 feet in length, by an average width of 14 feet, and is 9 feet 8 inches high; two of its sides, the northerly and westerly, are bold and in part overhanging. One heavy charge of dualin on top of the main rock, and a smaller charge on the next largest of the boulders, will suffice to break them into suitable pieces to be hoisted on board the working-vessel or grapple for with a clam-shell dredge.

Pinnacle Rock proper contains 54¼ cubic yards; the group of smaller rocks, 24 cubic yards; total number of tons of rock to be removed, 175.

Rock off J. Friend's wharf, (at D on sketch.) Distant from it about 300 feet is the cropping out of a granite ledge in the shape of a comb, having a bold easterly and southeasterly face. The highest part has 13 feet of water over it, the surrounding bottom 16½ feet. It measures 22 feet in length by 12 feet in width, and is 3½ feet above the surrounding bottom. A few drill-hole charges will remove it. It contains 22 cubic yards, or about 49 tons of rock.

Rock off Pew's wharf, (at E on sketch.) A small granite boulder of about 6 or 7 tons, rising about 1½ feet above surrounding bottom; can be easily hoisted or rolled out of the way.

Estimated cost of removal of rocks in Gloucester Harbor.

Babson's Ledge:	
670 cubic yards of boulders, say 1,500 tons, at $8	$12,000 00
Clam Rock:	
30 cubic yards of ledge, say 67 tons, at $10	670 00
Pinnacle Rock:	
78¼ cubic yards of boulders, say 175 tons, at $10	1,750 00
Rock off J. Friend's wharf:	
22 cubic yards of ledge, say 49 tons, at $10	490 00
Rock off Pew's wharf:	
Small boulder, say 6 tons, at $10	60 00
Total estimated cost of removal of rocks	14,970 00
Add 5 per cent. for estimated cost for contingencies	748 50
Grand total of estimated cost	15,718 50

RECAPITULATION.

Estimated cost of breakwater	$494,148 65
Estimated cost of removal of rocks	15,718 50
Total cost of projected improvements in Gloucester Harbor	509,867 15

Very respectfully, your obedient servant,

H. F. BOTHFELD,
Civil Assistant.

Lieutenant Colonel J. G. FOSTER,
Corps of Engineers.

GLOUCESTER, *September* 1, 1870.

DEAR SIR: I have the honor to acknowledge the receipt of your communication of the 29th instant, relative to lands at Fort Point, in Gloucester Harbor. I herewith submit a copy of the town records, dated May 12, 1794, showing the original power of jurisdiction granted by the town to the United States.

The question as to what land, other than that occupied by the fortifications, belonged at that time to the town, will be difficult to settle. The outlines of the old fort are plainly visible, and can be comprehended at a glance. If the Government has a claim upon any land there, that occupied by the old fort would doubtless be recovered. Mr. Rogers has not occupied that portion of the land covered by the old fort, but he has taken down the walls and parapets and placed his fences on the line of the outer wall of the fort. There is no record of jurisdiction ceded by the State, as there is of all other property held by the United States in this district.

Another question would be, whether the town had the right to cede jurisdiction; and in case it had, the total abandonment by the Government of the fort (the guns being removed at the time of the Mexican war) would not have any claim by the United States, the land reverting to the town, it having been ceded conditionally for a fortification, and the United States ceasing to use it as such.

Mr. Marsh, the administrator of the estate of Mr. Rogers, claims that he has deeds of all the lands occupied by Mr. Rogers; this does not include the fort.

The town, as you will see by the vote, granted all the land where the fort now stands.*

Babson's History of Gloucester mentions two appropriations for fortifications at Watch House Neck previous to May 12, 1794, and speaks of the present fort being built upon the lines of those works, which is no doubt correct. Therefore, either the United States or the town owns the land covered by the fort.

The property would bring about $800 or $1,000. There is also a piece of land on High street, in this town, of which I think the Ordnance Department has cognizance. There is a brick building on it used for the storage of guns during the war of 1812. I assisted Captain Williams in measuring it about two years ago. I should recommend that all of this property be sold, as it is of no practical use to the Government.

Respectfully, your obedient servant,

F. T. BABSON,
Collector District of Gloucester.

Lieutenant Colonel J. G. FOSTER, *U. S. E.*

"At the annual meeting held in Gloucester on Monday, May 12, 1794, (selectmen presiding,) under the fourth article of the warrant, which reads as follows:

"4th. To know the minds of the town concerning Fort Hill"—

"*Voted*, That the selectmen of this town cede to the United States of America all the land, the property of the town, on Watch House Neck, so called, where the fort now stands, for the purpose of erecting a fortification thereon.

"I, David W. Low, hereby certify that I hold the office of town clerk of Gloucester, Massachusetts, and that the foregoing is a true and correct transcript from record-book No. 3, pages 390 and 391 of said town.

"Witness my hand this 1st day of September, A. D. 1870.

"DAVID W. LOW,
"*Town Clerk of Gloucester.*"

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* NOTE.—This is not strictly correct; the town granted "all the land, the property of the town, on Watch House Neck, so called, where the fort now stands."

J. G. FOSTER,
Lieutenant Colonel of Engineers.

Statistics of the tonnage, &c., of the district of Gloucester for the year ending June 30, 1870.

Vessels boarded by revenue-boat, 3,390.

Value of imports	$74,013 00
Value of exports	8,383 00
Duty assessed	66,649 09

226 vessels entered, 24,528 tons; 155 vessels cleared, 19,377 tons.

Tonnage of the district, 570 vessels, 30,279.86 tons. Value of the products of fisheries, $3,724,500.

7,000 vessels (estimate) have made a harbor here.

CUSTOM-HOUSE, GLOUCESTER,
Collector's Office, November 26, 1870.

SIR: In accordance with your request I herewith transmit statistical facts relative to Gloucester Harbor, compiled from the books of this office.

I also submit a record of losses in Gloucester Harbor from some of the several storms since 1839:

December 15, 1839.—Total wrecks, 23 vessels; dismasted, 32 vessels; lives lost, 20.

January 1, 1840.—Six vessels lost, and 1 life lost.

October 3, 1841.—Four vessels wrecked, 2 driven out to sea and abandoned, and 5 dismasted.

January 19, 1857.—Five vessels driven to sea, 4 wrecked on shore, 3 dismasted.

February 24, 1862.—Four vessels driven on shore and wrecked.

January 17, 1867.—Four vessels driven on shore.

March 25, 1868.—Three vessels driven out to sea, and 2 wrecked on shore.

December 9, 1868.—Three vessels driven on shore.

December 12, 1868.—Seven vessels injured.

February 5, 1868.—Thirteen vessels struck on Dog Bar.

September 8, 1869.—Seven vessels wrecked.

To this may be added a large number of accidental losses, equaling 25 per cent. of the general loss.

It will be observed from the marine report that thousands of vessels seek shelter in this harbor yearly.

The immediate local tonnage is well protected in the inner harbor. The losses from wreck fall principally from the coasting vessels. During easterly storms a heavy undertow or swell is thrown into the harbor, which is the principal cause of the wrecks. If this were averted by the breakwater, the outer harbor, which is principally used by coasters, would be safe as the inner harbor. Often, during severe storms, much damage is done to vessels lying at the wharves by the heavy sea thrown in. Whatever may be the local benefit derived from the breakwater, it will be more than equally shared by all vessels, both from the Atlantic ports of the United States and the British Provinces.

In regard to the question of the rights of Government in the land at Fort Defiance, I would say that the record of the vote of the town, furnished by Major Low, over his certificate as town clerk, and forwarded in a former letter, is the best authority we have at present.

B. H. Smith, esq., surveyor of this district, and one of our ablest lawyers, is now investigating the whole affair, and you will be furnished with a report embracing all the facts that can be ascertained.

The land and building on High street, formerly used for storing ordnance, is covered by a deed, now in possession of the Ordnance Department. Captain Williams, the officer in charge of the sea-coast defenses, at one time took the measurement of this land for the Department.

I am, respectfully, your obedient servant,

F. T. BABSON, *Collector.*

Major General JOHN G. FOSTER, *Boston.*

V 20.

PRESERVATION AND IMPROVEMENT OF BOSTON HARBOR, MASSACHUSETTS.

The several works contemplated for the preservation and improvement of this harbor, remaining unfinished on the 1st of July, 1870, were as follows, viz:

1. Sea-wall for the protection and preservation of Point Allerton.
2. Sea-wall for the protection and preservation of Gallop's Island.
3. Sea-wall for the protection and preservation of north head of Long Island.
4. The removal of Kelly's Ledge.
5. Dredging a channel through the Upper Middle Bar.

These several works were under the charge of Lieutenant Colonel John G. Foster, Corps of Engineers, until the 25th of May, 1871, when they were transferred to my charge.

On the 1st of July, 1870, there was an unexpended balance available for these works of	$74, 619 32
And by an act of Congress approved July 11, 1870, there was appropriated therefor	100, 000 00
And by act of March 3, 1871	100, 000 00
Total	274, 619 32
Amount expended during the fiscal year ending June 30, 1871	195, 975 15
Balance available July 1, 1871	78, 644 17

1. SEA-WALL AT POINT ALLERTON.

Work was commenced upon this sea-wall in the latter part of September, 1870, under a contract made on the 24th of May, 1870, with Mr. James M. Andrews, of Biddeford, Maine, and was carried on by him until the 1st of June, 1871; and by hired labor during the latter part of June.

The following tabular statement exhibits the condition and progress upon this work during the past year, viz:

Number.	Character of work.	Work done during the fiscal year ending June 30, 1871.			Work remaining to be done in completion of the wall to its contemplated length of 1,230 feet.
		By contract of May 24, 1870.	By hired labor.	Total.	
1	Granite facing, (linear feet)	433¾	40½	474¼	755¾
2	Granite coping, (linear feet)	216⅔	29⅓	246	980
3	Concrete foundation and backing, (cubic yards)	1, 603	167	1, 770	2, 563
4	Excavation for foundation, (cubic yards)	2, 138	162	2, 200	3, 140
5	Back filling, (cubic yards)	1, 600	43	1, 643	2, 631
6	Granite paving, (superficial yards)				2, 050
7	Dry wall, (cubic yards)				80
8	Grading bluff back of sea-wall, (cubic yards)				4, 920

The estimated cost of the completion of the sea-wall to the contemplated length of 1,230 feet is $92,300.

2. SEA-WALL AT GALLOP'S ISLAND.

The construction of this sea-wall was commenced in the year 1868, and continued in 1869 and 1870. The wall proper was completed about the middle of October, 1870, its total length being 1,745 feet.

The operations upon this wall during the fiscal year ending June 30, 1871, were carried on until the end of April under a contract made May 26, 1868, with Mr. James Andrews, of Biddeford, Maine; and afterward by hired labor and hired machinery.

The following tabular statement exhibits the condition and progress upon this work during the fiscal year, viz:

Number.	Character of work.	Work done during the fiscal year ending June 30, 1871.			Work remaining to be done in completion of the wall to a total length of 1,745 feet.
		By contract of May 26, 1838.	By hired labor.	Total.	
1	Granite facing, (linear feet)	406¾	....	406¾	....
2	Granite coping, (linear feet)	396	....	396	....
3	Concrete foundation and backing, (cubic yards)	1,097	....	1,097	....
4	Excavation for foundation, (cubic yards)	808	....	808	....
5	Back filling and grading, (cubic yards)	4,108¾	826	4,934¾	5,000
6	Granite paving, (superficial yards)	208⅝	970⅝	1,179¼	1,136
7	Dry wall, (cubic yards)	75	....	75	50

Estimated cost of completion of this sea-wall is $9,500.

All the work will probably be finished by the end of September, 1871, except grading the bluff, which it is proposed to defer until another season.

3. SEA-WALL ON THE NORTH HEAD OF LONG ISLAND.

The construction of this sea-wall was commenced about the middle of August, 1870, by Mr. James Andrews, of Biddeford, Maine, under a contract dated May 24, 1870, and was continued by him until the 1st of June; and afterward by hired labor during the latter part of June. The length of the sea-wall as now contemplated is 2,100 feet.

The following tabular statement exhibits the condition and progress on this wall during the past year, viz:

Number.	Character of work.	Work done during the fiscal year ending June 30, 1871.			Work remaining to be done in completion of the wall to its contemplated length of 2,100 feet.
		By contract of May 24, 1870.	By hired labor.	Total.	
1	Granite facing, (linear feet)	670	53.5	723.5	1,376 5
2	Granite coping, (linear feet)	350.375	....	330.375	1,733
3	Concrete foundation and backing, (cubic yards.)	1,720.5	126	1,846.5	3,416
4	Excavation for foundation, (cubic yards)	1,632	110	1,742	3,180
5	Back filling and grading, (cubic yards)	1,168	78	1,246	8,215
6	Granite paving, (superficial yards)	....	....	....	3,460
7	Dry wall, (cubic yards)	....	....	....	50

Estimated cost of completing this sea-wall to its total contemplated ength of 2,100 feet is $114,700.

4. REMOVAL OF KELLY'S LEDGE.

This ledge lies in the main ship-channel, directly in the line from the entrance-buoy to Spit light, and had originally only 16 feet of water upon it at mean low water.

Operations to reduce it, by submarine blasting, to a depth of 23 feet at mean low water were commenced in 1869, and at the close of the season, after many difficulties, only about one-half the work on this rock was completed.

In the latter part of 1870 operations were resumed but were again suspended on the 30th of December, on account of the very unfavorable weather. Owing to the unfavorable character of the rock, the progress in its removal has been very slow from the beginning. Since the 1st of July, 1870, 459 tons of rock have been removed and deposited upon the shore, and about fifty tons have been thrown into deep water near the rock, making the total quantity removed since the commencement of operations amount to 834 tons.

There still remain two or three points of ledge having a depth of but 21½ feet at mean low water, which should be reduced to the required level of 23 feet at mean low water, which can be accomplished in a few days of favorable weather.

The removal of this rock secures a great advantage to navigators in enabling them to make one straight course from the entrance-buoy to the spit light.

5. DREDGING A CHANNEL THROUGH THE UPPER MIDDLE BAR.

The contemplated plan for the improvement of this bar consists in the excavation of a channel to a width of 1,000 feet, and a depth of 23 feet at mean low water, the distance across the bar being about 2,200 feet.

The operations upon this bar are reported by Lieutenant Colonel Foster, (in a special report dated January 2, 1871,) to have been as follows:

> The peculiar character of the material of this bar, a very hard indurated yellow clay, (hard pan,) prevented the different machines that were successively tried during the three past seasons from succeeding. During this season, however, Mr. E. R. Seward, of Albany, the contractor, (under his contract of May 24, 1870,) with the assistance of Mr. C. H. Montine, has succeeded in making one straight cut, 2,200 feet in length, entirely through the bar, to a depth of 23 feet at low water, and a width of 45 feet. This cut is marked by three spar-buoys.
>
> Eighteen thousand six hundred cubic yards of material have been dredged and dumped during the season.

The contract price for this work was 85 cents per cubic yard.

Operations were resumed by the contractor, in a second cut on this bar, in the spring of 1871, and were continued until the 1st of June, 1871, when the contract was closed.

There were excavated in the second cut 7,520 cubic yards, making a total of 26,120 cubic yards in both cuts.

Under instructions from the Engineer Department, proposals were again invited on the the 22d of June for continuing this work under the appropriation of March 3, 1871, to the extent of 50,000 cubic yards, more or less, of dredging.*

The completion of this channel to a width of 1,000 feet would require the additional excavation (taking the amount excavated in the first cut as a basis) of, say, 385,000 cubic yards, which, at 60 cents per cubic yard, amounts to $231,000.

---

*On the 29th of July, 1871, a contract was made with Mr. R. G. Packard, of Brooklyn, New York, the lowest of five bidders, for doing this work at 57 cents per cubic yard.

The following is a recapitulation of the estimates for the completion of all the incomplete works of improvement named above, viz:

1. Sea-wall on Point Allerton	$92,300 00
2. Sea-wall on Gallop's Island	9,500 00
3. Sea-wall on north head of Long Island	114,700 00
4. Completing the removal of Kelly's Ledge, (say)	500 00
5. Completion of the channel through the Upper Middle Bar to a width of 1,000 feet	231,000 00
Contingencies, (say)	45,644 17
Total	493,644 17
Amount available July 1, 1871	78,644 17
Additional amount required for completing the contemplated improvements	415,000 00
Of this amount there could be expended to advantage, during the next fiscal year, the sum of	$175,000 00

On the several works as follows, viz:

1. Sea-wall on Point Allerton, 500 linear feet, at $100	50,000 00
2. Sea-wall on Gallop's Island, in completion of work	9,500 00
3. Sea-wall on north head of Long Island, 800 linear feet, at $75	60,000 00
4. Completing the removal of Kelly's Ledge	500 00
5. Dredging the channel through the Upper Middle Bar to an additional width of 150 feet	37,500 00
Contingencies	17,500 00
Total, (as above)	175,000 00

For the further prosecution of the above works during the fiscal year ending June 30, 1872, proposals have been invited for continuing the sea-walls on Point Allerton, and on the north head of Long Island, as well as for dredging in the Upper Middle Bar,* to the extent allowed by the available balance of the appropriation for that year, and it is expected that the sea-wall on Gallop's Island will be completed by the end of September, 1871, except the grading of the bluff in its rear.

V 21.

BOSTON, MASSACHUSETTS, *January* 10, 1871.

GENERAL: As the operations of the year upon the works of improvement in this harbor have closed, and as the greater portion of the work accomplished was done during the latter part of the season, and consequently not included in my report at the close of the fiscal year—June 30—it seems to be a proper and favorable time for presenting a comprehensive report of the whole season's work; and, also being of interest in the connection, to give a brief sketch of the plans adopted for the preservation and improvement of the harbor, the progress thus far made in their execution, the results and ascertained facts, and the proper conclusions to be drawn from them.

---

* The following contracts have been made for these works, viz:

Contract, dated July 26, 1871, with Mr. James M. Andrews for sea-wall on Point Allerton.

Contract, dated July 26, 1871, with Mr. James M. Andrews for sea-wall on Long Island.

Contract, dated July 29, 1871, with Mr. R. G. Packard for dredging on the Upper Middle Bar.

The estimates above *given* for the total completion of these works have been based *upon the prices* contained in these contracts.

The natural boundaries of Boston Harbor include all the expanse of tide-water lying within a line drawn from Point Allerton to Point Shirley, and extending from that line westward to the shores of the mainland.

This comprises a surface area of nearly 31,000 acres, from which, deducting the area of the islands within the harbor, nearly 1,000 acres in extent, gives a water area of the harbor of 29,700 acres. This large expanse is well sheltered from the ocean by Point Allerton and the ten seaward islands, among which the most important are Deer Island, Lovell's Island, and the three Brewster Islands. These islands and the adjacent headlands constitute the natural breakwaters of the harbor, through which the two deep channels, the Main Ship-Channel and Broad Sound Channel, pass in such a manner that all vessels, as soon as they are fairly within the portals of the harbor, are within easy access of well-sheltered roadsteads.

The large interior basin of the harbor is fortunately divided into many excellent anchorages, both for light and heavy-draught vessels, by the favorable position of the numerous islands in the harbor. Of the eighteen of these that appear on the chart the most important, in respect to the protection they afford to shipping, are George's Island, Gallop's Island, Long Island, Peddock's Island, Castle and Governor's Islands.

George's Island shelters the shipping in George's Roads from the easterly gales, and also a part of Nantasket Roads from northerly winds.

Gallop's Island also affords protection to George's Roads on the north, and to the Main Ship-Channel on the west and southwest.

Long Island shelters the President's Roads from the south and southeast storms, and George's Roads from the northwest and westerly gales.

Peddock's Island protects Hull Basin on the northwest, and a large portion of Nantasket Roads on the south. Castle and Governor's Islands afford protection to the upper harbor, as the portion of the harbor lying west of Fort Independence is usually termed, in contradiction to the lower harbor, which comprises all the water surface eastward to the entrances.

The first-class anchorages, under shelter of the above islands, for vessels of 23 feet draught, at all stages of the tide, are as follows:

	Acres.
Nantasket Roads, containing	1,720
Hull Basin, containing	730
George's Roads, containing	490
President's Roads, containing	1,010
Upper Harbor, containing	200
Total	4,150

The above does not include the areas of the Main Ship-Channels nor the anchorages north of the Lower Middle Ground. It does include the area of the upper harbor, because it is now connected with the deep waters of the lower harbor, a cut having been made by dredging during the past season entirely through the Upper Middle Bar to a depth of over 23 feet at mean low water. This cut, now only 45 feet in width, it is proposed to widen during the next and following seasons to 300 feet, or more if navigation shall require it.

Nearly all the islands of the harbor are now entirely destitute of trees. A few remain upon Apple Island, and a small number have been planted on George's Island by the Government since the construction of Fort Warren; yet history and tradition both agree in stating that at the time of the first explorations by the Pilgrims, nearly all the islands were well wooded. Some of them bore evidence of having been inhabited and cleared for cultivation.

The new work by Hon. N. B. Shurtleff, entitled "Topographical and Historical Description of Boston," contains many interesting extracts from old records showing the impressions made upon the first explorers by the natural advantages of the harbor.

One writer, in 1634, says:

> It is a safe and pleasant harbor within, having but one common and safe entrance and that not very broad, there scarce being room for three ships to come in board and board at a time; but being once within, there is anchorage for 500 ships.
>
> This harbor is made by a great company of islands, whose high cliffs shoulder out the boisterous seas, yet may easily deceive any unskillful pilots, presenting many faire openings and broad sounds which afford too shallow water for any ships, though navigable for boates and small pinnaces.
>
> The entrance into the great Haven is called *Nantascot.* This place of itself is a very good Haven, where ships commonly cast anchor until Winde and Tyde serve them for other places. From hence they may sayle to the river of Wessaguscus, Neponset, Charles River, and Misticke River, on which rivers bee seated many Townes.
>
> In any of these fore-named harbours the seamen, having spent their old store of wood and water, may have fresh supplies from the adjacent Islands, with good timber to repair their weather-beaten ships. Here likewise may be had masts or yards; being store of such trees as are useful for the same purpose.

The same writer, in 1635, says:

> These isles abound with woods and water and meadow-ground, and whatever the spacious fertile maine affords, &c.

It is not remarkable that the great value of the harbor and the advantages afforded to the anchorage grounds by the numerous islands should have strongly impressed the early explorers.

Its natural advantages strongly impress at the present time all those who carefully study its physical characteristics.

Professor Henry Mitchell, in a recent unpublished report, says:

> The great merit of Boston Harbor lies in a happy conjunction of many favorable elements, among which we may distinguish as most important the facility and safety of its approaches, the ample width and depth of it entrances, and, above all, the shelter and tranquillity of its roadsteads.
>
> Perhaps there is no other harbor in the world where the inlets from the ocean are better adjusted to the amplitude of the interior basins, and whose excellent holding-grounds are so easy of access and yet so land-locked. I quote from the highest authority in my profession, when I declare that the primary requisite for a good harbor is that "the internal area should bear such a relation to the width of entrance as to produce a sufficient degree of tranquillity;"* and so difficult has it been to properly adjust this relation in artificial harbors, that nearly one-half of all these works may be set down as failures, because the entrances are either too narrow to admit vessels under trying circumstances, or the interior reservoirs too small to dissipate the waves that run in from the sea.
>
> In natural harbors where the primary requisite cited above is fulfilled, it often happens that the interior basin is so large that the local effects of strong winds are sources of discomfit and even danger, as in San Francisco. Boston Harbor has no such drawbacks; her interior water-space is large, but is divided by chains of islands into basins which offer sufficient room for the heaviest ships to ride freely at anchor, and sufficient tranquillity for the frailest fishing-boat.

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* Stevenson on Harbors.

It does not appear, however, that the early settlers properly appreciated the value of the trees upon the islands as affording additional protection to the anchorage-grounds, or serving as a protection for the islands themselves against the assaults of the winds and waves.

The early records are interspersed with permits and votes of towns authorizing the cutting off the trees and wood upon the islands. The destruction of this natural protection appears to have rapidly progressed. This was a serious loss, as it deprived the vessels of one-half the shelter afforded by the islands against the winds.

To illustrate the estimate that would be placed upon the loss of such protection in the present era of large ships with lofty masts and large spars, I again quote Professor Mitchell, in saying:

> "There are times when shelter from the wind is scarcely less important than smooth water. In the harbor of Cherbourg the inrun of the waves is most effectually arrested by the great moles, and yet nearly every vessel that sought its shelter in the gale of 1865 was driven on shore by the wind. Here again Boston Harbor claims peculiar advantages; here moles are promontories and islands, rising from 20 to 100 feet above the sea, so as to shelter the hull of a ship and much of her top hamper."

The extent of the loss as protection for the islands themselves may be estimated from the amount of the resulting injury.

The sides of the islands and headlands being exposed to the full force of the winds, and their shores to the cutting and dissolving action of the waves, intensified by the lower sweep of the winds, were subjected to gradual destruction.

The effect of the waves in storms dashing against the exposed shores is evident to any observer; portions of the material of the formation are dislodged by every dash of the waves, the lighter particles being borne back by the receding waves or undertow, are either deposited at once in front of the abraded bluff or are carried away by the currents to other points, where, becoming checked in motion, they are deposited to form bars or shoals, encroaching upon the roadsteads or channels. The portions of the material too heavy to be borne by the currents are sometimes driven by the force of the waves along the shore until the moving forces cease or are neutralized.

As the lighter material is washed away, the boulders fall out, and rolling down to the foot of the bank, remain there, forming in time an apron of stone, to serve as a protection against further encroachments. Thus the very process of destruction operates in time to protect against further destruction. But the removal of these water-worn and rounded stones to serve as ballast, or paving-stones, necessarily exposed more of the bank, to be washed down, until a new crop of stone was produced.

Whatever the precise character of the action may have been, the results soon became so apparent as to attract public attention, and to alarm those interested in the preservation of the harbor.

Some islands were found to have been entirely washed away, leaving dangerous shoals in their places. Ram's Head, a small island situated 550 yards northeast of the north head of Lovell's Island, and once containing several acres, had entirely disappeared, leaving one of the most dangerous shoals at the Broad Sound entrance. Upon this shoal, about forty years ago, the Maine Packet was wrecked, and all the passengers, fifteen in number, perished of exposure and cold.

Nixe's Mate, once a considerable island, according to the old colony records, which shows that, on the 8th of September, 1836, "there is twelve acres of land granted to John Galop, upon Nixe's Island, to enjoy to him and his heirs forever, if the island be so much.

Des Barre's chart of the survey of 1769 shows Nixe's Mate to have been at that time an island containing about six acres. This island was long since washed away, leaving in its place a shoal, dangerous from its proximity to the main channel, upon which many vessels, each year, run aground.

Bird Island Shoal, in the upper harbor, was once an island, and inhabited in 1634.

This washing away of the island and headlands early called attention to the necessity of the preservation of what remained.

In the year 1827, an appropriation from Congress was obtained for the construction of a sea-wall for the protection of Deer Island, and a dry stone wall was built on the east side of the island, in three sections, covering the three prominent heads.

In 1843, on petition of the city of Boston, the legislature of Massachusetts instructed its Senators and Representatives in Congress to exert themselves to obtain an appropriation to further protect the harbor. By their exertions an appropriation of $15,000 was obtained, and expended by Colonel Sylvanus Thayer in the construction of a sea-wall on the north head of Lovell's Island.

Other appropriations were subsequently made for this island and Great Brewster Island, on each of which substantial and costly sea-walls have been built and maintained by the General Government.

These islands, being the larger of the seaward islands, at the entrances to the harbor, were the first to receive the attention of the General Government in the way of protection. But the islands lying more westerly in the harbor were also justly regarded as requiring protection, being important as the more immediate shelters for the safest and best anchorage.

In June, 1856, the legislature of Massachusetts passed "An act to protect Boston Harbor," which prohibited the taking of stone, gravel and sand, from the islands and headlands of the harbor except by license from the city of Boston.

At the request of the city of Boston, the General Government, in 1860, appointed a board of commissioners to examine the Boston Harbor. This board consisted of General J. G. Totten, Chief Engineer, United States Army, Professor A. D. Bache, Superintendent United States Coast Survey, and Commander C. H. Davis, United States Navy.

Under the direction of this board, but at the expense of the city of Boston, extensive hydrographical and physical surveys of the channels and shoals, and topographical surveys of the shores of the islands, were made by Coast Survey officers.

From these surveys were prepared elaborate and detailed maps and tables of results, clearly showing the injurious changes that had taken place, and indicating the measures necessary to be taken to check them. These surveys and results were from time to time, from 1860 to 1866, communicated to the city government of Boston, in carefully-prepared and elaborate reports. In these reports the commissioners strongly urged the construction of sea-walls for the preservation of the prominent headlands of the harbor, using in their second report the following strong language to express their conviction:

> First, that injurious changes are going on unceasingly; and, second, that the time is approaching when those who are responsible for the preservation of Boston Harbor must make up their minds either to abandon the lower harbor to its fate, or to make immediate application of the remedy, and the only remedy by which the progress of these injuries can be arrested.
>
> The remedy is manifestly the continuation of the old and the construction of new sea-walls; a *proper grading* of the hills, and a planting of a suitable grass or shrub on *the unsheltered* surfaces.

Professor Henry L. Whiting, of the United States Coast Survey, who made the topographical survey, ascertained the probable original extent of the prominent headlands and islands, by completing the contour curves in a manner analogous to the curves of existing hills in the neighborhood, thus ascertaining the amount washed away. According to his estimates, the Little Hill of Point Allerton originally extended beyond the present position of the beacon, and was about 100 feet high. It was, at the date of the survey, reduced in height to 60 feet, and had lost by washing away nearly 43 acres. The loss in thirteen years, from 1847 to 1860, had been 22,000 square feet. The loss of the Great Hill of Point Allerton had been in thirteen years, from 1847 to 1860, 40,000 square feet. The Great Brewster Island had lost over 30 acres, the encroachments extending to the summit of the largest hill. Two hundred and twenty thousand square feet had been washed away in the thirteen years preceding 1860.

Deer, Lovell's, Gallop's, Long, and other islands, had all lost by washing away in a similar manner, but many of them in a less proportion.

The board of harbor commissioners, organized by the legislature of Massachusetts in 1866, took up the matter with active interest, and caused carefully-prepared plans and estimates to be made of the cost of sea-walls, and of deepening and widening the Main Ship-Channel by dredging, and the removal by blasting of dangerous rocks lying in the channel.

These plans and estimates were forwarded, with a petition to Congress, to the Chief of Engineers, (yourself,) by whom those for the most important objects, viz, sea-wall for Point Allerton, Gallop's Island, and north head of Long Island, dredging off the southwest point of Lovell's Island, the west extremity of the Great Brewster Spit, and the Upper Middle Bar, together with the removal of Tower and Corwin Rocks, were approved and recommended to the Secretary of War, by whom they were also approved. By these approvals, and the exertions of the harbor commissioners, and representation of the State in Congress, an appropriation was at once obtained from Congress of $375,000, $300,000 of which were for the new works estimated for, and approved by you, and which were placed in my charge.

In 1868, Congress further appropriated $33,000, in 1869, $83,000, and in 1870, $100,000 more, making in all, in four years, the amount of $516,000 for these new works.

The progress made up to the present time in these several works in my charge, is as follows.

REMOVAL OF THE ROCKS IN THE CHANNELS.

In 1867, operations in drilling and blasting Tower Rock, situated 100 yards southwest from the Great Brewster Spit light, resulted, after a few months of successful work, in the reduction to a depth of 23 feet at mean low water.

Operations were then commenced on Corwin Rock, situated 100 yards southwest of Tower Rock. This being a much larger rock, work was continued during the whole season of 1868, and again in the summer of 1869, in the month of June of which year its entire removal to the depth of 23 feet at low water was accomplished.

Operations were then commenced on Barrel Rock, a boulder lying in Broad Sound, about one mile a little north of west from Green Island, and near the sailing line of the Portland and other Maine steamers. Having only 4 feet of water at low tide, it constituted in thick weather a dangerous obstacle to navigation. It was successfully blasted, and the fragments were all removed to the shore or into deep water.

Operations were then commenced on Kelly's Ledge, a rock with 16 feet of water upon it, lying in the Main Ship-Channel, directly in the line from the entrance buoy to the Spit light.

Heavy-draught vessels, being obliged to pass either to the right or left of this rock, necessarily incurred considerable danger in foggy weather from the proximity of the extensive Centurian Rocks on one side, and of the Beacon Rocks, near the edge of Brewster Spit, on this other. The season closed when about one-half the work on this rock was completed. It was resumed the past season, and diligently prosecuted; but owing to the very unfavorable character of the rock, being a soft slate, with contorted laminations, filled with crystals of sulphuret of iron, (iron pyrites,) which impeded the action of the drill, the progress of the work was necessarily very slow. The heaviest charges of powder and other explosives used failed to produce much effect upon the soft rock. The work was stopped on the 30th of December, on account of the weather, and before two or three high points left by the blasts had been reduced to the required level of 23 feet at low water, although the general surface was below that level.

These few points have now 21½ feet of water at low tide upon them, and can easily in a few days of favorable weather be blasted down to the requisite level. The removal of this rock secures a great advantage to navigators in enabling them to make one straight course from the entrance buoy to the Spit light.

THE GREAT BREWSTER SPIT.

No attempt has yet been made to cut off by dredging the west extremity of this spit, because during the removal of Tower Rock the divers observed and reported that the rock rose in a gradual ascent toward it, and evidently formed the back-bone of the spit; the projections or ridges being outcroppings of the general ledge of rocks underlying this part of the harbor, running in a northeast and southwest direction and forming the foundation of the Seaward Island, "whose high cliffs shoulder out the boisterous seas."

The deposits at the end of the spit have not, as yet, reached such deep water as to render their removal by dredging necessary.

Its present growth, as reported by the light-keeper, is toward the northwest and south, and has been quite rapid within a few years. The supply of materials for its growth appears not yet to be entirely cut off by the completion of the Great Brewster sea-wall.

The re-entering angle of that wall, on the east side, near the large hill, being very near the bluff, appears to permit the waves, when they have gathered force by being compressed in the angle, to mount the wall and dislodge large masses of the steep bank. This will probably continue until all the earth that can be reached by the breaking waves is washed away, or until the bluff is graded into a slope suitable to resist the action of the seas.

I do not therefore think it advisable to expend anything at present in dredging the extremity of the spit, but to await the ultimatum of the effects of the causes still remaining in force.

WIDENING THE MAIN SHIP CHANNEL BY DREDGING OFF THE SOUTHWEST POINT OF LOVELL'S ISLAND.

This work was commenced in 1868 and continued in 1869; the whole point was cut off for a width in a direction perpendicular to the axis of the channel, of 260 feet, from the top of the bank, in a regular slope to the depth of 23 feet at low water. This has caused a slight increase of the ebb scour through the narrows, which has appreciably enlarged the widening, and smoothed off all projecting ridges left in the hard bottom by the buckets of the dredges. This improvement has widened the channel at this point, at the depth of the 18-foot curve, from its former width of 365 feet to 625 feet, a gain of 260 feet.

Nothing more, in my opinion, need be done at this point of Lovell's Island, but I propose to dredge off the extremity of a shoal making out from the east side of Gallop's Island, on the opposite side of the channel. Upon this spit, called Cape Cod Shoal, many vessels get aground at low water, and it is a much needed improvement to dredge off its point in a line parallel to the axis of the channel, so as to make the channel as wide at that point as it now is at other places.

DREDGING A CHANNEL THROUGH THE UPPER MIDDLE BAR.

The peculiar character of the material of this bar, a very hard, indurated yellow clay, (hard-pan,) prevented the different machines that were successively tried during the three past seasons from succeeding. During this season, however, Mr. E. A. Seward, of Albany, the contractor, with the assistance of Mr. C. H. Montine, as sub-contractor, has succeeded, making one straight cut, 2,200 feet in length, entirely through the bar, to a depth of 23 feet at low water, and a width of 45 feet. This cut is marked by three spar-buoys. Eighteen thousand six hundred cubic yards of material have been dredged and dumped during the season. The widening of this cut will be continued during the next season, in which, it is expected, a width of 300 feet will be obtained.

SEA-WALL AT GALLOP'S ISLAND.

The construction of the wall for the protection of the north and east sides of this island was commenced in 1868 and continued in 1869 and 1870. The wall proper was completed about the middle of October last. The earth backing has been filled in for about two-thirds of the length of the wall, and its west end has been connected with the bank by a short dry wall, with an apron of stone in front. The stone for the flagging to be placed back of the coping course is on hand, ready to be laid during the coming season. The character of the wall is shown in the accompanying sketch. It has a strong granite facing of headers and stretchers, with dovetailed joints, and a compact concrete backing. Its height varies from 14 to 17 feet, (having an extra course at the bottom for a portion of its length.) Its thickness is 9 feet at bottom and 5 feet at top. Its foundation is a compact mass of concrete 3 feet thick and 13½ feet wide. This foundation is laid in a trench, excavated to an extremely compact stratum of gravel and clay, or hard-pan. It is located nearly on the line of ordinary high water. The total length of the wall is 1,745 running feet.

The appropriation called for in the annual report of June 30, 1870, is much needed to complete, in the next season, the back filling of earth, to lay the granite flagging back of the coping, and to slope down and grass the steep face of the bluff.

CONSTRUCTION OF SEA-WALL AT THE NORTH HEAD OF LONG ISLAND.

Operations were commenced by the contractor, Mr. James Andrews, about the middle of August last, and continued during the season.

A wharf for landing materials was constructed by him at the northwest point of the head, for which a railroad track was laid to the location of the wall. A cement house was built by me, and quarters for his men by the contractor.

During the season, the foundation-course for 524 feet in length of the wall was built, and three courses above the foundation laid to nearly the same extent.

A large amount of material is on hand, ready for the next season's work.

This wall is to be of a character similar to that of the Gallop's Island sea-wall. Its cross-section is seen in the accompanying sketch.

SEA-WALL FOR THE PRESERVATION OF POINT ALLERTON.

This exposed and rapidly disappearing headland should, from its important character, have been protected at the earliest possible day; but owing to the numerous delays in obtaining a deed of the site, and the privilege of locating in a safe place the wharf for landing materials, the work of construction was not commenced until this season.

A wharf was then built on the northerly and sheltered side of Stony Beach, 440 feet in length, extending to the channel, and a cement house was erected near by. A railroad track for conveyance of materials was laid by the contractor, Mr. James M. Andrews, from the wharf to the site of the sea-wall, a distance of 4,200 feet; quarters for his men and sheds for materials and tools were erected by the contractor.

These preliminary arrangements occupied so much time that the first pit for the foundation was not started till the last of September, and the work continued only to the 1st of December. In this time, 322 feet of foundation and the two first courses of the wall were laid, and backed with concrete and earth. This wall is similar in character to the Gallop's Island sea-wall, but is made stronger and higher, on account of its exposed situation. Its cross-section is seen in the accompanying sketch.

It is located nearly on the high-water line, and its foundation is placed at a greater depth, and upon the same kind of hard-pan substratum, as was obtained for the other walls. It is to be of sufficient length to inclose the face of what remains of Little Hill. It is expected that the appropriation asked for will complete the wall proper, in the coming season. It is hoped that these timely preservative means to save the remains of Little Hill may also arrest the washing away of Great Hill.

Point Allerton, one of the most marked and prominent headlands that meet the eye of the mariner in approaching the harbor, will thus be preserved nearly in its present distinctive characteristics. The only alterations will be in the features of Little Hill, and will consist of the substitution of the profile of the sea-wall terminating in a graded and grassed slope for the present rugged aspect and seamed face.

It appears from the directions on the Coast Survey chart, under the head of "Ranges," that this headland is a prominent guide for avoiding the dangers of Harding's Ledge, when passing to the southward of it, in entering or leaving the harbor.

"Point Allerton Bluff," says Professor Mitchell, in his recent letter to the harbor commissioners, "remembered first and foremost in your prayers to Congress, is the *pier-head* of the natural mole that defends the lower roadsteads. If it were suffered to waste away the Hull Basin would be utterly ruined, and as the opening of the harbor widened, the other anchorage ground would become unsafe.

"Within the past thirty-eight years, the French government has expended some eight and a half millions of francs for the shore protection of the neck of land which forms the *leeward* point, the embouchure of the Gironde."

"The reasons assigned for this expenditure were, that the point, by falling back, threatened to expose the roadstead of Verdon, and that the pass into the ocean would diminish in depth if suffered to expand."

In seeking to ascertain where the materials washed away from this point have been carried, and if any have been deposited in the main channel, I caused a careful comparison of all the surveys from 1769 to the present time to be made. The results of this comparison, shown in the comparative map accompanying my letter of April 13, 1870, shows that within the limits covered by the comparative map, extending about 2,000 feet outside of the entrance and 5,000 feet within, covering an area of the main channel of 451 acres, there had been a shoaling to the extent of nearly 5,000,000 cubic yards of material. Were this immense quantity spread out over Boston Common, it would cover it to the depth of 64 feet.

This great deposit did not probably all come from Point Allerton; in fact, its source can only be ascertained positively by an accurate and minute geological survey, as recommended by Professor Agassiz, in his letter of September 11, 1867, published in the Coast Survey report for that year.

The movement of the curves of depth outwardly toward the channel is, however, a strong indication that much of the shoaling came from the point.

The comparative map shows a very decided outward movement of the 12, 18, and 24 feet curves, the latter curve having moved out about 1,000 feet. The deeper curves have moved less; some of the deepest ones have, however, been entirely obliterated.

The 48 and 54 feet curves shown on Wadsworth's map of 1817, about half way between Point Allerton and Boston Light, are entirely wanting on the commissioners' map of 1863.

The general principles that guided the United States commissioners in their original investigations and reports upon Boston Harbor, and which likewise actuated the board of harbor commissioners for Massachusetts in their petitions and exertions for national aid, were those of *preservation*, and aimed "to preserve the great physical features in their ancient order, and to hold on to the old landmarks."

The reasons were threefold: First, to preserve the islands and headlands because of their value as shelters to the anchorage grounds; second, because the material washed from them *must be deposited* somewhere in the roadsteads and channels, to the injury of navigation; third, because "as these bluffs fall back they leave in their places dangerous shoals and reefs, hidden for the most part, especially at high tide, and these embarrass the navigator, even when he is familiar with their existence and whereabouts."

During the few years that I have had charge of the works recently undertaken to carry out the above principles of preservation, I have had the advantage of being intimately associated with the harbor commissioners of Massachusetts and Professors Whiting and Mitchell, of the Coast Survey, both of whom have been connected with this subject from the commencement of the surveys of the United States commissioners to the present time, and are thoroughly acquainted with the details and scope of the original plans of the United States commissioners. I therefore had no hesitation in quoting freely from them.

My own observations during this time have confirmed my appreciation of the wisdom of the course originally recommended, since adopted, and thus far carried out for the preservation and improvement of this, one of the most important harbors upon the whole Atlantic coast.

I have the honor to be, very respectfully, your obedient servant,

J. G. FOSTER,
Lieutenant Colonel of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

V 22.

IMPROVEMENT OF TAUNTON RIVER, MASSACHUSETTS.

The improvements contemplated for this river consist in excavating a channel to a width of 60 feet, and a depth of 4½ feet at mean low water, (or 9 feet at high water,) through the several shoals which obstruct its navigation between Dighton and Weir Village, in the city of Taunton, (a distance of about five miles.) A survey of this river, made in 1852 by Lieutenant W. S. Rosecrans, United States Engineers, shows that there are four shoals requiring improvement, the lowest of which, called The Needles, is about two miles above Dighton Village.

By an act of Congress, approved July 11, 1870, there was appropriated

for this work the sum of	$10,000 00
And by act of March 3, 1871	10,000 00
Total	20,000 00
Amount expended during the fiscal year ending June 30, 1871	608 00
Balance available July 1, 1871	19,392 00

It having been decided to apply the appropriation made for the improvement of this river to deepening its channel to the width and depth contemplated as above, proposals were invited for the work by Lieutenant Colonel John G. Foster, on the 6th of September, 1870, but no satisfactory proposal was received in response thereto. Again, on the 8th of October, he invited proposals for the work; in response to which five proposals were received—that of Mr. Edgar M. Payn, of Albany, being the lowest, at $1 50 per cubic yard, for the excavation of material of all kinds.

A contract was accordingly made with Mr. Payn for doing the work; but some unforeseen difficulties arose which caused him to abandon his contract.

Again, on the 21st of February, 1871, proposals for the work were invited by General Foster, and on the 29th of March, 1871, he entered into a contract with Mr. Emory R. Seward, of Albany, New York, for doing the proposed work, at $5 per cubic yard, the work to be commenced on or before the 1st of July, 1871, and to be completed on or before the 30th of June, 1872.*

On the 25th of May, I relieved General Foster from the charge of this work.

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* *On the 7th of July,* 1871, Mr. Seward commenced work under his contract.

The cost of the contemplated improvements in this river is es by General Foster to be as follows, viz: the quantity estimated for the same as reported by Brevet Major Jared A. Smith, cap engineers, viz:

For shoal No. 1, 4,000 cubic yards, at $1 50	$6,0
For shoal No. 2, 6,700 cubic yards, at $2	13,4
For shoal No. 3, 3,600 cubic yards, at $3	10,8
For shoal No. 4, (The Needles,) 3,600 cubic yards, at $5 25	15,7
At Dighton, 800 cubic yards, at $1	80
Bukley's Bridge, 350 cubic yards, at $1	[illegible]
For contingencies, 10 per cent	4,7
Total	51,8
To which add for underestimates for the work required at The Needles, say	2,5
Total	54,3
Amount available July 1, 1871, (as above)	19,3
Additional amount required for the completion of the contemplated improvements	35,0

Which amount could be profitably expended during the fis ending June 30, 1873.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals received.
2. Abstract of contracts.

Abstract of proposals received for the improvement of Taunton River, Massach sponse to advertisement dated September 6, 1870.

No. for reference.	Nature of work.	Names of bidders.	Price per	
			Sand, &c.	[illegible]
1	Dredging channel	George Hastings, New Bedford, Mass	$3 4	[illegible]
2	do	Staples & Phillips, Taunton, Mass	2 5	[illegible]
3	do	E. R. Seward, Albany, N. Y	2 0	[illegible]
4	do	E. M. Payn, Albany, N. Y	1 9	[illegible]
5	do	George W. Townsend, Boston, Mass	4 5	[illegible]

Abstract of contracts made for the improvement of Taunton River, Massach

No. for reference.	Nature of work.	Name of contractor.	Quantity.	Pr
			Cub. yard.	Cub. yd
1	Dredging channel	E. M. Payn, Albany, N. Y	*4,000	[illegible]
2	do	Emory R. Seward, Albany, N. Y	4,000	[illegible]

* More or less.

V 23.

IMPROVEMENT OF PLYMOUTH HARBOR, MASSACHUSETTS.

This work was under the charge of Lieutenant Colonel John G. Foster, Corps of Engineers, until the 25th of May, 1871, when it was transferred to me.

This harbor has for many years past been subject to more or less injury, owing to the action of the easterly gales in breaking through Long Beach, which is a tongue of land extending northeasterly from the mainland for a distance of about three miles, and affording to the harbor its only protection from the open ocean. Several plans appear to have been adopted from time to time for the protection of this beach, to prevent its removal by the violent storms to which it is exposed. The plan which has recently been adopted by General Foster to protect it has been attended with excellent success. It is to construct a bulk-head with lateral jettees made of frame-work filled in with brush, and ballasted with stone, by which work the force of the waves and the movement of the sand are checked, thereby forming a beach which continually enlarges and increases the strength of the work. And when finally it becomes covered with sand, this is still further increased and strengthened by planting beach-grass upon it, by which, also, the movement of the sand is in great measure checked, whilst the grass continues to grow up through the sand and forms a barrier to the action of the storms. In localities where this work has not proved effectual, and is not likely to do so, the beach has been protected by an apron-work of stone, which thus far appears to have answered its purpose. This brush bulk-head is of such a perishable nature that it is constantly liable to injury from storms, and otherwise, and may at any time require repairs to prevent its total destruction, until the sand has accumulated around it in sufficient quantity to increase its stability. It will, therefore, be necessary to make an appropriation from year to year sufficient to meet the cost of such repairs as may be necessary, which repairs should be made on the first indication of any necessity therefor, so as to prevent the possible total destruction of the work.

By an act of Congress, approved July 11, 1870, there was appropriated for the improvement of this harbor	$10,000 00
And by act of March 3, 1871	10,000 00
Total	20,000 00
Amount expended during the fiscal year ending June 30, 1871	11,093 49
Amount available July 1, 1871	8,906 49

The amount expended, as above, during the year was, for the most part, applied by General Foster to the construction of about 1,700 feet of brush bulk-head and jettees, under a contract made August 10, 1870, with Messrs. J. E. & G. Bowley, of Provincetown, Massachusetts. This work they commenced in September, 1870, and finished before the close of the season.

Under instructions from the Department, proposals were invited by General Foster, on the 6th of April, 1871—

1st. For completing the brush bulk-head and jettees near the extremity of Long Beach, in response to which five proposals were received, that of Mr. J. A. Blaisdell, of Greenland, New Hampshire, being the lowest, at $3 86 per linear foot of the work completed; and

2d. For delivering and piling stone upon the bulk-head connecting the extremity of Long Beach with the beacon, in completion of same; in response to which six proposals were received, the lowest being that of Mr. George Clapp, of Boston, Massachusetts, in which he offered to furnish the stone at $2 25 per ton.

Contracts were made by me with Mr. Blaisdell, on the 26th of May, and with Mr. Clapp, on the 27th of May, for the performance of the works respectively awarded to them. In the month of June, both contractors had made satisfactory progress under their contracts, with a probability of their being completed about the 1st of September, 1871. In addition to which some repairs were made with hired labor upon the existing bulk-head and jettees.

On the completion of the work now required and under contract, together with the repairs necessary to be made on the old work, there will probably be an unexpended balance of about $1,500, which is deemed sufficient to defray the expenses of such repairs as may be necessary up to the 30th of June, 1872. But in order to be prepared for the occurrence of any damage, which at any time may be caused by storms, and for its immediate repair, it is respectfully recommended that the sum of $2,500 be appropriated therefor for the next fiscal year.

The papers described as follows are hereto appended, viz:

1. Abstract of proposals for the work.
2. Abstract of contracts.

Abstract of proposals received for the improvement of Plymouth Harbor, Massachusetts.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1	For delivering and piling upon the stone bulk-head connecting the beacon with the extremity of Long Beach of 2,000 tons of large irregular blocks of granite.	Charles T. Derry, Boston, Mass.	2,000 tons, more or less.	$3 87 per ton.
2	......do	Sargent, Mead & Sampson, Quincy, Mass.	....do	3 75 per ton.
3	......do	D. V. Howell, New York City.	....do	2 95 per ton.
4	......do	Isaiah Gifford, Provincetown, Mass.	....do	2 75 per ton.
5	......do	F. B. Cobb, Plymouth, Mass.	....do	2 70 per ton.
6	......do	George Clapp, Boston, Mass.	....do	2 25 per ton.
7	For the construction at the extremity of Long Beach of about 800 running feet of brush bulk-head and jettees.	J. E. & G. Bowley, Provincetown, Mass.	....do 800 running feet, more or less.	6 00 per running foot.
8	......do	Isaiah Gifford, Provincetown, Mass.	....do	5 95 per running foot.
9	......do	George Clapp, Boston, Mass.	....do	5 27 per running foot.
10	......do	F. B. Cobb, Plymouth, Mass.	....do	4 25 per running foot.
11	......do	James A. Blaisdell, Greenland, N. H.	....do	3 86 per running foot.

Abstract of contracts made for the improvement of Plymouth Harbor, Massachusetts.

Number for reference.	Nature of work.	Name of contractors.	Quantity.	Price.
1	Furnishing and piling large irregular blocks of granite.	George Clapp, Boston, Mass.	2,000 tons, more or less.	$2 25 per ton.
2	Constructing bulkhead and jetties.	James A. Blaisdell, Greenland, N. H.	450 running feet, more or less.	3 86 per running foot.

V 24.

IMPROVEMENT OF HYANNIS HARBOR, MASSACHUSETTS.

This harbor derives its importance chiefly from the protection which it affords to the coasting trade against violent storms from every quarter. By the breakwater alone it is protected from southerly and southwesterly storms. This work is about 1,170 feet in length, and its general course about east-southeast. It was built several years since, of blocks of stone thrown in at random, to about the height of high water. These stones have become more or less displaced by the violent storms to which they have been exposed, and the height of the work has thereby so much decreased that of late it has not afforded all the benefit for which it was intended. In order to give it the required height and stability, it has been in part reconstructed in the following manner, viz: the random stone has been rebuilt from low water, where the work has a thickness of 20 feet, up to about 4 feet above high water, where it has a thickness of 16 to 18 feet; upon this foundation is placed two courses of top wall, having a rise of 3 feet and a width of 10 feet.

For the purpose of rebuilding this work, the following appropriations have been made by Congress during the past year, viz:

By act of July 11, 1870	$12,000 00
And by act of March 3, 1871	10,000 00
Total	22,000 00
Amount expended during the fiscal year, ending June 30, 1871	12,096 50
Amount available July 1, 1871	9,903 50

Under the appropriation of July 11, 1870, a contract was made on the 17th of September, 1870, by General Foster, with Mr. George Clapp, of Boston, Massachusetts, (after advertising for proposals,) for reconstructing this work, at $38 62 per running foot, and on the 6th of June, 1871, 300 feet of the work was completed under that contract. Proposals were again invited by General Foster, on the 6th of May, 1871, for extending the work of reconstruction under the additional appropriation of March 3, 1871.

On the 25th of May, 1871, the charge of this work was transferred from General Foster to myself. On the 6th of June following I opened the proposals received for this work, two in all, and awarded the contract to Mr. George Clapp, of Boston, Massachusetts, who was again the lowest bidder, at $37 50 per running foot. By this contract, which was made on the 9th of June, 1871, and approved by the Department, Mr. Clapp is required to complete his work, to the extent that the appropriation would admit of, on or before the 30th of November, 1871.

On the 30th of June he had built up 175 feet of the work ready for the top wall, under his new contract, with a probability of finishing 250 feet of the work, (the length required for the completion of his contract,) about the 1st of September, 1871, leaving 225 feet of the work still to be rebuilt.

The amount available for this work on the 1st of July, 1871, will be nearly all if not quite exhausted by the work now contracted for.

So that to complete the necessary 225 feet there will be required, (estimating its cost at $40 per lineal foot)	$9,000 00
Adding for contingencies	1,000 00
Total amount required for the completion of the breakwater ..	10,000,00

This amount can be profitably expended upon the work during the next fiscal year.

The papers described as follows are appended hereto, viz:

1. Abstract of proposals received in October, 1870.
2. Abstract of proposals received in June, 1871.
3. Abstract of contracts for the work.

Abstract of proposals received for the improvement of Hyannis Harbor, Massachusetts, in response to advertisement dated September 3, 1870.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1	Repairing breakwater.	Edmunds & Lane, Pigeon Cove, Mass.	....	$755 68 per running foot
2	....	Sargent, Sampson & Meade, Quincy, Mass.	....	$72 00 per running foot.
3	....	M. K. Chase, Blue Hill, Me..	....	$57 00 per running foot
4	....	Derry & Edwards, Boston, Mass.	....	$47 30 per running foot.
5	....	George Clapp, Boston, Mass.	....	$38 62 per running foot.
6	....	James M. Andrews, Biddeford, Me.	....	$40 00 per running foot.

Abstract of proposals received for the improvement of Hyannis Harbor, Massachusetts, in response to advertisement dated May 6, 1871.

Number for reference.	Nature of work.	Name of bidder.	Quantity.	Price.
1	Rebuilding and completing the unfinished portion of the breakwater.	M. K. Chase, Blue Hill, Me..	250 feet, more or less.	$47 00 per running foot.
2	......do	George Clapp, Boston, Mass.	....do	$37 50 per running foot.

Abstract of contracts made for the improvement of Hyannis Harbor, Massachusetts.

Number for reference.	Nature of work.	Name of contractor.	Quantity.	Price.
1	Repairing breakwater.	George Clapp, Boston, Mass.		$38 62 per running foot.
2	Rebuilding and completing the unfinished portion of the breakwater.	George Clapp, Boston, Mass.	250 feet, more or less.	$37 50 per running foot.

V 25.

IMPROVEMENT OF PROVINCETOWN HARBOR, MASSACHUSETTS.

The works for the improvement of this harbor were under Brevet Major General John G. Foster, Lieutenant Colonel of Engineers, until the 25th of May, 1871, when they were transferred to me.

The work hitherto done for the improvement and preservation of this harbor is as follows, viz:

1. Bulkheads and jettees of various descriptions have been built from time to time along Beach Point, for its preservation and protection, both by the United States Government and by the local authorities.
2. A dike was built in 1868, by the State of Massachusetts, across the outlet of East Harbor Creek.
3. A dike was built in 1869, by the United States Government, across East Harbor Creek, at the Wading-Place, near High Head, about two miles above the outlet of the creek.
4. A dike was built in 1870 across the head of Lancey's Harbor, at Abel Hill, in order to prevent the washing and flowing of sand through that place down into the main harbor of Provincetown.
5. Wooden bulk-heads and jettees have been built at different times for the protection and preservation of the beach on Long Point.
6. A stone apron-work has been commenced for the protection and preservation of the outer end of Long Point, opposite the light-house and the three-gun battery.
7. Beach-grass has been planted on Long Point Cove Section and Oblique Section, and at the last two places brush has also been laid for their further protection.

Of the above work, the following has been done during the fiscal year ending June 30, 1871, viz:

1. The dike across the head of Lancey's Harbor was built in the latter part of the year 1870, under a contract made by the engineer then in charge of the work, with Isaiah Gifford, of Provincetown. This dike consisted of a frame-work filled with brush and ballasted with stone, having an apron-work of stone on each side of it. It has since been overturned and destroyed by the action of the tidal currents in undermining its foundations.
2. The brush bulk-head and jettees on Beach Point have been repaired where most necessary.

All the above-named works, with the exception of the dike at Lancey's Harbor, have answered an excellent purpose.

A very extensive and accurate survey has also been made during the months of May and June, 1871, which embraces all the points of interest in and near this harbor, and showing, by comparison with the various former surveys, the changes that have since occurred.

The amount of funds that were available for this work on July 1, 1870, was	$5,131 57
Amount appropriated therefor by act of March 3, 1871	6,000 00
Total	11,131 57
Amount expended during the fiscal year ending June 30, 1871	2,102 32
Amount available July 1, 1871	9,029 25

The contemplated work yet to be done for the preservation and improvement of this harbor is as follows, viz:

1. A dike across the head of Lancey's Harbor, at Abel Hill, the estimated cost of which is	$3,500 00
2. The repair of the existing bulk-head and jettees, and planting of beach-grass along Beach Point and the State Dike now required, say	1,000 00
3. Completing the stone apron-work for the protection of Long Point, requiring about 1,000 tons	3,000 00
4. A work to prevent the extension of the flats between Stevens's Point and Lobster Point, estimated at	4,000 00
5. The planting of beach-grass for the protection of the outer sand-hills lying between the State Dike and Cove Section, for an extent of nearly one mile, say	3,000 00
6. To provide for annual repairs of the bulk-heads and jettees, say	2,500 00
Contingencies	2,029 25
Total	19,029 25
Amount available July 1, 1871, (as above)	9,029 25
Amount required for the fiscal year ending June 30, 1873	10,000 00

Which could be profitably expended upon the work in that year.

Respectfully submitted.

GEO. THOM,
Lieutenant Colonel Engineers.

APPENDIX W 1.

Annual report on the works of river improvement in Oregon for the fiscal year ending June 30, 1871.

UNITED STATES ENGINEER OFFICE,
Portland, Oregon, September 6, 1871.

SIR: I have the honor to submit the following report of the operations of this office for the works of river improvement in Oregon, during the fiscal year ending June 30, 1871.

At the opening of the year the work was under the charge of Major R. S. Williamson, Corps of Engineers, assisted by Lieutenant William H. Heuer, Corps of Engineers.

On the 11th of April, 1871, in compliance with Special Orders No. 124, dated March 28, 1871, from the War Department, Adjutant General's Office, I relieved Major R. S. Williamson at San Francisco, California, from his duties as superintendent of river improvement in Oregon, being at the same time assigned to duty as engineer of the 13th light-house district.

On the 13th of April I sailed for Portland, Oregon, arriving on the 17th. On the following day I visited the dredger at Swan Island Bar, which was at work under a general order from Major Williamson.

The water having risen suddenly 2 feet and a strong current running, with appearances of stormy weather, I gave orders to lay up, which was accordingly done on April 19, the crew being discharged, and the boats loaned by the city of Portland to the Engineer Department placed in charge of a watchman. I then visited the site of the Yaquina light-house, returning to Portland on the 28th of April, established this office on the 2d of May, and left on the 12th for Cape Disappointment, and afterward for San Francisco on business connected with my duties as light-house engineer, arriving at Portland again on the 30th of May.

MOUTH OF THE WILLAMETTE RIVER.

At this point, two years ago, a channel about 1,000 feet long, 100 feet wide, and 17 feet deep at low water, was cut. I have not had time to visit this point, but hope to do so during the summer. I find, however, that the general opinion among river-pilots and steamboat-men is that this channel cannot be kept open without dredging each year. One vessel grounded here this year, and had to be lightered, at great expense, before she could be got over, and vessels drawing 18 and 19 feet of water never attempt to cross this bar now without lightering. This subject will be more fully referred to below.

LOWER WILLAMETTE RIVER.

Swan Island Bar.—Work at this point has been in progress at different times during the last four years. The result of the work performed this spring season is the deepening of the channel to 17 feet at low water for a distance of 85 linear feet, besides cleaning out of 100 feet in length by 45 to 100 feet wide and 2 feet deep of the old cut, this latter being the deposit made by the unusually long winter freshet. The amount of excavation was 1,400 cubic yards, including 900 cubic yards cleaned out of the old channel. There remains yet a distance of 2,000 linear feet to be cut through, varying in width from 100 to 250 feet, when the channel will be completed to a depth of 17 feet at low water, and for a distance of one mile. The character of the work hitherto performed here is of a very satisfactory nature, and it is believed when completed it will need only occasional work to keep a good channel open. I do not think that the work in this bar can be completed this year, in consequence of the short period intervening between the summer and fall freshets; but expect to resume operations about the 10th of August next, which will consist, as formerly, of dredging on the line of the cut, and removing any snags lodged during the present season of high water.

COLUMBIA RIVER.

In connection with the improvement of the Willamette River, the question of access thereto naturally arises, and it appears that obstructions in the channel of the Columbia River, below the mouth of the Willamette, have been forming, which are now serious obstacles to the development of the foreign trade of this port. I refer especially to the St. Helen's Bar, about twenty miles below the mouth of the Willamette, the old channel through which has seemingly been filled up within the last two years, causing constant and extended delays to vessels of 17 or 18 feet draught. By the annexed statement furnished me by the collector of customs for this district, it will be seen that during the past nine months 106 vessels, of an aggregate tonnage of 73,714 tons, have arrived at this port. Of these 70 were steamers, 5 ships, 23 barks, and 8 brigs and schooners, and many were heavily laden with railroad iron, and took out, on their departure, full cargoes of wheat hence to Liverpool and China.

There are two English firms in this city, Messrs. Corbett and McCleary, and Messrs. Hewitt, Flowerdon & Co., constantly engaged in shipping wheat directly to Liverpool, which, before the opening of the Swan Island Bar, found its exit by steamer to San Francisco, and there was reshipped for exportation. Since October last, the coin collections at this port alone amounted to $210,000, and more than twenty vessels with full cargoes have arrived in this river from distant foreign ports, taking out from hence full cargoes of domestic produce. This is exclusive of the trade with British Columbia, in which two steamships are constantly employed besides occasional sailing-vessels. The coastwise trade, especially with San Francisco, is very large, and constantly increasing, but cannot be estimated closely for the reason that vessels engaged therein are not required, except in certain cases, to report at the custom-house.

The following instances will evince the difficulties which confront the masters of large vessels coming to this port: The British bark Skidder, now in port from England, with railroad iron, was detained several days on the bar at the mouth of the Willamette, and only got over it by sending forward one-third of the cargo on lighters. The duty collected on this cargo exceeded $17,000. The British iron ship Dorenby, also in port now, with a similar cargo, grounded on the St. Helen's Bar, and was brought into port only by lightering. The duties paid on her cargo aggregated nearly $19,000. The American bark Garibaldi, just arrived with a full cargo from China, was delayed for some time on the St. Helen's Bar. Duties on her cargo exceeded $15,000. The British ship Bristolian, drawing 19 feet of water, is now in the mouth of the Columbia River, and steamboats are going down from here a distance of one hundred and ten miles to lighter her ere she can ascend the river to this point. All these ships are chartered to take return cargoes, one-half of which they will take at the wharves of this city, then dropping down below St. Helen's, a distance of thirty-five miles, will there receive the remainder from steamboats. In order to secure return cargoes of wheat, &c., vessels from distant ports must arrive here in the latter part of the summer, which is the season of extreme low water in these two rivers.

In view, therefore, of the rapid increase of the commerce of these rivers, and the material injury thereto by the obstacles presented by these two bars, I would respectfully recommend that I be authorized to make such examinations at St. Helen's and the mouth of the Willamette as will be necessary to determine the best method of removing these obstructions to navigation.

The dredger hitherto used on the improvement of the Lower Willamette is the property of the city of Portland, has been in use five years, during four of which it has been loaned to the engineer officer in charge by the city authorities, is an ordinary single-dipper dredge, built hunriedly by contract, and will not last much longer. It is too small for the work, cost originally $25,000, coin, and the annual expense of keeping it in repair has been about $3,000. There is no other dredger in this part of the country, and as one will be needed from time to time on Swan Island Bar, annually at the mouth of the Willamette, and on the new bar at St. Helen's, I would respectfully recommend that an appropriation be asked, for the construction and fitting out of a steam-dredger and two scows, of $35,000 for the former, and $4,000 for the latter.

The probable operations for the year 1871–'72 will consist of a continuation of dredging on Swan Island Bar, the cut through which will not be completed until the summer of 1872; also of such examinations and work as I may be authorized to make on the bar at the mouth of the Willamette, and which may be necessary to keep that channel open.

During the fiscal year the following amounts were received and expended on account of the improvement of the Willamette River at Portland, Oregon, and to mouth of river:

Balance July 1, 1870	$11,046 02
Appropriated July 11, 1870	31,000 00
Total available	42,046 02
Expended during the year	24,329 48
On hand July 1, 1871, and available	17,716 54
Estimated cost of completing Swan Island work with the present dredger	17,000 00

Estimate for the fiscal year 1872–'73.

Construction and fitting out of a steam-dredger for use on the Lower Willamette and Columbia River Bars	$35,000 00
Construction of two scows for use with dredger	4,000 00
Running expenses for season	11,000 00
Total	50,000 00

UPPER WILLAMETTE RIVER.

A survey was made by Major Williamson of the worst bars, with a view to estimating the cost of improving the navigation on this river. (See Major Williamson's report of December 12, 1870, Senate Ex. Doc. No. 14.)

Amount appropriated	$16,000 00
Available July 1, 1871	16,000 00

The probable operations for the ensuing year will consist of an examination of the points most favorable for work during the coming low-water season; the construction of a Long's scraper, and a snag-boat with snag-pulling apparatus, and work with these appliances whenever and wherever it may be found to be most needed. Wing-dams will also be built in several places. After the experience of this summer's work, a report will be made, with an estimate for such funds as may be required for next year's work.

UMPQUA RIVER.

A reconnaissance by Major Williamson was made of the rapids of this river, (Senate Ex. Doc. No. 14,) and appropriation made by Congress of $22,500, which was available July 1, 1871.

An examination of this stream will be made immediately and a project submitted for the expenditure to best advantage of the appropriation. Probable operations during the ensuing year will consist of blasting a channel through the most dangerous rapids.

No appropriation asked for the year ending June 30, 1873.

Respectfully submitted.

HENRY M. ROBERT,
Major of Engineers, United States Army.

Tonnage arrived and departed from the customs district of Willamette, from October 1, 1870, *to June* 30, 1871, *nine months inclusive.*

52 steamers, 1 ship, 19 barks, 6 others, inward coasting, tonnage	59,426
18 steamers, 4 ships, 4 barks, 2 others, inward foreign, tonnage	14,288
70 steamers, 5 ships, 23 barks, 8 others, total	73,714
58 steamers, 5 others, outward coasting	52,611
21 steamers, 3 ships, 12 barks, 1 other, outward foreign	20,901
	73,512

Tonnage owned in customs district of Willamette, June 30, 1871.

	Tonnage.
5 sail	749.77
30 steamboats	7,043.24
6 barges	334.58
Total tonnage	8,127.59

H. W. SCOTT,
Collector,
Per W. S. DUSENBURY.

A true copy:

HENRY M. ROBERTS,
Major of Engineers, United States Army.

W 2.

SAN FRANCISCO, CALIFORNIA,
August 3, 1871.

GENERAL: I have the honor to submit the following report of operations, under the appropriation for examinations and surveys on north and northwest rivers and lakes, and Atlantic and Pacific coasts, for the fiscal year ending June 30, 1871.

Under this appropriation I have made examinations and surveys of Upper Willamette and Umpqua Rivers in Oregon, and of the Sacramento River, California. Full and detailed reports of each work, accompanied by maps and estimates of the cost of proposed improvements, have been forwarded to the Chief of Engineers.

The following statement shows the amount received and expended during the year:

On hand July 1, 1870	$0 00
Received during the year	10,000 00
Total on hand and received	10,000 00
Expended	4,526 58
Deposited to credit of Treasurer of United States	5,473 42
Balance on hand June 30, 1871	0 00

Respectfully submitted.

R. S. WILLIAMSON,
Major, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA,
August 3, 1871.

GENERAL: I have the honor to submit the following report of operations, under the appropriation for "surveys of military defenses," for the fiscal year ending June 30, 1871:

The work of reducing meteorological observations has been continued from time to time during the year; the computer, however, was employed during most of the time on other work, which was paid for out of other appropriations. Finally he resigned, on the 31st of May last, and his place has not been filled. A quantity of observations are still uncomputed.

The following are the amounts received and expended during the fiscal year ending June 30, 1871:

On hand July 1, 1870	$563 85
Received during the year	600 00
Total	1,163 85
Expended during the year	1,103 34
Balance on hand June 30, 1871	60 51

Respectfully submitted.

R. S. WILLIAMSON,
Major, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA,
August 3, 1871.

GENERAL: I have the honor to submit the following report of operations, under the appropriation for "surveys and examinations on the Pacific coast," for fiscal year ending June 30, 1871:

No field work has been done under this appropriation during the past fiscal year. I am directed by the Chief of Engineers, United States Army, to make examinations of Eureka and Santa Cruz Harbors during the present fiscal year, and to pay for the same out of this appropriation, which will be done.

The following statement exhibits the amounts on hand, received, and expended during the past year:

On hand July 1, 1870	$4,473 40
Received during the year	0 00
Total on hand and received	4,473 40
Expended during the year	694 82
Balance on hand June 30, 1871	3,778 58

Respectfully submitted.

R. S. WILLIAMSON,
Major, Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA,
August 3, 1871.

GENERAL: I have the honor to submit the following report of operations under the appropriation for "improvement of Willamette River at Portland, and mouth of river Oregon," for the fiscal year ending June 30, 1871.

This work has been carried on under the immediate charge of my assistant, Lieutenant W. H. Heuer, Corps of Engineers, United States Army.

The operations on this river during the past fiscal year have been confined to dredging on Swan Island Bar. Work was recommenced on the 8th of August, 1870, and continued uninterruptedly until the 24th of December, 1870. During this time, 23,765 cubic yards of material (clay and sand) were excavated, and 1,594 linear feet of channel of 17 feet deep made. This makes a channel of 17 feet in depth by 100 feet in width at the bottom, for a length of 2,299 feet. There yet remains to be cut through about 1,500 linear feet of channel, as above, which now contains 15 feet of water.

The cost of the dredging this year has been 95.5 cents per cubic yard.

The following is a statement of funds received and expended during the year:

On hand July 1, 1870	$0 00
Received during the year	11,000 00
Expended during the year	10,746 34
Balance on hand July 1, 1871	253 66

The balance has been turned over to Major H. M. Robert, Corps of Engineers, who, by direction of the Chief of Engineers, United States Army, relieved me from duty, under this appropriation, on the 31st of March, 1871.

Respectfully submitted.

R. S. WILLIAMSON,
Major Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA,
August 3, 1871.

GENERAL: I have the honor to submit the following report of operations under the appropriation for "repairs, &c., of works on harbors and rivers" for the fiscal year ending June 30, 1870. The only operations carried on under this appropriation during the past fiscal year was the removal of the Blossom Rock. The contractor, Mr. A. W. Von Schmidt, by surface-blasting, dredging, and raking, succeeded in obtaining the depth of water required by his contract. A careful survey to ascertain these facts was made by my assistant, Lieutenant W. H. Heuer, Corps of Engineers, United States Army. The work was accepted by me on behalf of the Government on the 8th of December last, and the contract money ($75,000) was paid to Mr. Von Schmidt, the contractor. A full and detailed report of the operations for removing this rock from their commencement until the acceptance of the work by me has been sent to the Chief of Engineers, to which I respectfully refer you.

The following statement exhibits the amounts received and expended by me during the year:

On hand July 1, 1870	$80,394 53
Received during the year	0 00
Total accounted for	80,394 53
Expended during the year	76,406 34
Balance on hand June 30, 1871	3,988 19

Respectfully submitted.

R. S. WILLIAMSON,
Major Corps of Engineers, U. S. A.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

W 3.

SAN FRANCISCO, CALIFORNIA,
December 23, 1870.

GENERAL: I have the honor to forward herewith a report of a survey of the Willamette River, above Oregon City, Oregon, by my assistant, Lieutenant W. H. Heuer, United States Engineers. The object of the survey being to afford data to determine the nature of the obstructions to the navigation of the river, and the probable cost of its improvement, it was evidently not necessary to make a minute survey except of those portions of it where obstacles exist. The portions of the river examined extended from Corvallis to the falls at Oregon City; the obstacles above Corvallis are so numerous at the low stages of the river, and so difficult of removal, that I did not think it necessary to extend the survey above that place.

I have the honor to be, very respectfully, your obedient servant,

R. S. WILLIAMSON,
Major United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA,
December 23, 1870.

MAJOR: In accordance with your order of September 7, 1870, I left Portland, Oregon, with my party, on September 8, and proceeded up the Willamette River by steamboat to Salem, Oregon. This was done to see the obstructions to the navigation of the river, as well as what had been done toward improving it by the Steamboat Company.

After leaving Oregon City we steamed up the river for about five miles and arrived at Rock Island, where the river widens and the channel becomes tortuous. During high water the river rushes down the channel, which contains points of rocks and rocky reefs, under which eddies are formed, rendering navigation difficult; but during ordinary stages of the river, steamboatmen consider it perfectly safe. They do not, therefore, deem any immediate improvement necessary. After leaving Rock Island the river contains a good depth of water, until we arrive opposite the mouth of Molalla River, one of the tributaries of the Willamette, ten miles above Oregon City, where a shoal is formed consisting of small gravel and boulders. As the boats cross the shoal without difficulty, no improvement is deemed necessary here. Proceeding farther up the river, we find deep water, until arriving just below the mouth of the Yamhill River, another tributary, about thirty-five miles above Oregon City. Here a shoal extends entirely across the river, carrying about three feet of water. The river is about 1,000 feet wide, the channel narrow, and the current rapid. The shoal is gravel, which vary in size, but averaging about four inches in length, nearly flat, with rounded edges. This shoal is probably due to the increased width of the river, as well as to the grav brought down by the Yamhill River during its annual freshets. The river might temporarily improved here by a system of wing-dams, but the boatmen say that oth bars higher up the river are so much worse than this one that they do not consider t Yamhill Bar a serious obstacle to navigation.

Between Yamhill Bar and Salem are numerous shoals, covered by 24 to 30 inches de of water, with deep water between them. The names of the bars are Runaway Bar, B nett's Dread, Five Islands, Tow Head, Matheney's, Beaver and Lone Tree Rapids, McCl key's Chute, and Chitwood Bar. Each of these shoals are of the same nature. Of t bars just mentioned, Matheney's, Beaver, and Lone Tree Rapids and Chitwood Bar are t worst, on account of the channel being less wide and more tortuous than on the ot bars. The depth of water is about the same on each of these bars.

Steamboats navigate the river between Oregon City and Salem (sixty-five mi during the entire year, and as far as Corvallis, forty-two miles above Salem, du nine months of the year. During a high-water stage of the river, they run up as f Eugene City, about eighty miles above Salem.

From the 1st of October to the 1st of August the river is said to be high, and boats make their trips regularly, transporting heavy loads of freight; after that gation above Salem ceases, and all towns above Salem either have to wagon t grain and supplies to or from Salem or stow them away until navigation reopens.

The bars between Salem and Corvallis are not very numerous. They are of a sim nature to those below, but have a few inches less depth of water, and the boul become larger as we go higher up the river. Above Salem we surveyed Humph Rapid and Bowers Bar. They are considered the worst bars in the whole river, a they were improved, it is thought navigation would open to Corvallis during the e year. The names of the other bars above Salem are Eola Bar, Rocky Rapids, I pendence Bar, Buena Vista Bar, Luckamute Bar, and Long Crossing. None of t however, are considered serious obstacles to navigation. The upper Willamette varies in width from 300 to 1,000 feet; its average width from Albany to Oregon C probably 500 feet. At every shoal on the river it is wider than it is immediately or below the shoal. The difference between the highest water and low water river varies at different places. Where the banks are high it is said to be as m 60 feet; at Salem it is about 40 feet. The banks of the river generally are lo heavily timbered for a distance of about half a mile in width; beyond that prairie land, forming by far the most valuable farming land in the State.

During the year, October 1, 1869, to October 1, 1870, 51,437 tons of freigh carried by the boats navigating the river. The People's Transportation Co monopolize the carrying trade of the river. They run seven steamboats a falls at Oregon City and two below. Within the last few years this comp improved the navigation at Chitwood, Matheney's and Runaway Bars by wing-dams in the river, thereby contracting its width and causing the i current to wash the finer gravel from the shoals into deeper water below the d

The results in some cases were satisfactory, and would have been better dams been better constructed and placed in more favorable localities. As a r were roughly constructed, and consisted of a log being thrown into th making an angle of about 135° with the current. Willow bushes and gr then thrown in on the up-stream side of the log. The log, being agr remain in place until the water raised, when it would be carried away instances the dams were const the river, then placing the logs against the piles, and brush and gravel against the logs. The dams so constructed are still standing.

The danger to be apprehended in building wing-dams in the river is, that the current striking the dam is deflected to the opposite shore, which, if it be of a soft character, is gradually washed away, leaving the river as wide as before the dam was constructed. When the banks are washing away, the trees fall into the river, ground, and offer a partial protection to further wash until the river rises and floats them off. The current then carries them off until they lodge on some gravel-bar, where they form a wing-dam, and sometimes produce a bad effect. The river pilots say that at nearly every bar the channel changes from year to year; it is, therefore, probable that any change which a wing-dam will produce on a bar will be temporary. It will produce an increased depth of water, but the gravel which it scours out will be deposited below, and may make another shoal as bad as the original.

Surveys were made of the following-named bars of the river, viz: Bower's Bar, Humphrey's Rapid, Chitwood Bar, Beaver and Lone Tree Rapids, and Matheney's Bar. Maps of each of these bars accompany this report. They will now be described in the above order, commencing at

BOWER'S BAR.

This obstruction is three miles above Albany. The river suddenly widens from 225 feet to 400 feet, where the shoal is found. The distance from 3 feet depth of water above, to the same depth below the shoal, is 150 feet. Average depth of water on the shoal is 2 feet. The current flows nearly west, with a velocity of 400 feet per minute. Immediately above the shoal the current is less rapid. The bed of the river is gravel, averaging about 2 pounds in weight; some of them, however, weigh as much as 20 pounds. Near the shoal are three bare gravel-bars, two of them on the north side of the channel, the other near the mouth of the creek on the south side of the channel. The lower of these bars is gradually washing away on the channel side. The south bank of the river is clay, stands nearly vertically, and is also gradually wearing away. The north bank is a gravelly shore, having a gradual slope from the water's edge for a distance of about 200 feet. Beyond that we find timber. The river can be improved here by building a wing-dam from the foot of the northerly gravel-bar to the head of the lower bar. This would be 325 feet long, would concentrate the current, and cause it to scour the shoal, but would also undermine the south bank and cause it to wash. This can be remedied by piling close to shore, and then throwing in logs and brush behind the piles; 500 linear feet of piling would probably suffice. The estimated cost of the wing-dam is $900; that of the bulk-head for shore protection, $2,600, making a total estimated cost of this improvement, $3,500.

After leaving Bower's Bar, we pass down the river without meeting with any serious obstacles until we arrive at

HUMPHREY'S RAPID.

This obstruction is about twenty miles, by river, above Salem. The bed of the river is gravel, like that on the other shoals, but the obstruction consists of two rocky reefs, nearly parallel to each other, about 150 feet apart, putting out from opposite sides of the channel. The lower one projects from the south shore, and is 125 feet in length, by an average width of 75 feet. The upper reef puts out from an island on the north side of the channel for a distance of 250 feet, and has an average width of 100 feet. These two obstacles cause the boat, in ascending or descending, to make two sharp turns in contrary directions, (like the letter S,) and the current being rapid, (nearly 400 feet per minute,) has a tendency to throw a boat, in crossing, broadside on the lower reef, which is covered by about 2 feet of water. The upper one is barely covered. A channel can be made by blasting through either of these ledges of rock, but the work would be very expensive. An equally good channel, at a small cost, can be made between the island and the north shore. This chute contains an average depth of 15 feet of water, except at its upper end, and for a distance of 300 feet, where there is less than 3 feet of water. This shoal, however, is all small gravel, none of it any larger than an egg; and if a wing-dam 220 feet long was constructed diagonally across the current, its lower end abutting against the head of the small gravel bar near the head of the island, the increased current would soon scour out the small gravelly shoal, and give a channel 75 feet wide in its narrowest part.

At the end of the island was an immense accumulation of drift, probably 20 feet high, which lodges there during every freshet. This was set fire to and burned out in a few days. The only objection to building a dam at the head of this bar is, that it might catch the drift and choke any channel which it might form. This is not probable, because the gravel-bar against which the dam would abut is about 3 feet high, whereas the top of the dam would be but a few inches above the water surface. The estimated cost of building this dam—220 feet in length—is $700.

The next *important* obstruction below this is called

CHITWOOD BAR.

This is about a mile and a half below Salem, and gives the steamboat men considerable trouble during low-water stage of the river. The river contains a long gravel-bar or island, the foot of which is about 600 feet above the shoal. At the shoal the river widens suddenly from 300 to 675 feet. Immediately above and below the shoal is a good channel, carrying upward of 3 feet of water. Length of the shoal between the 3-foot curves, above and below, is 475 feet. On the west bank, a little above the shoal, is a wing-dam 150 feet long; another was built from the foot of the island, and is 550 feet long. The shoal commences at the foot of the long wing-dam, and extends across the river, covered with from 20 to 30 inches of water. In the prolongation of the shorter wing-dam, and distant from its foot about 140 feet, is a pile driven into the gravelly bed of the river. In ascending the river, the boats hug the west bank until they arrive about 150 feet below the wing-dam; a line is then taken from the boat, and one end made fast to the pile, the other end remaining on board wound around the capstan. The boat then backs; the result is, that she is carried into mid-stream, and held there by the line. The engine is then quickly reversed, a few feet of progress made, and the spare line taken in. The probabilities are that by this time the boat is aground. She again commences to back, which throws a little water under her, and causes her to raise a trifle on the wave so produced. The engine is again quickly reversed, and more progress made. This process is repeated, sometimes for hours, until the boat reaches the pile, after which she has no more difficulty. While surveying this bar, a break 100 feet long occurred in the long dam near the foot of the island. The water, which was 2 feet deep before the break, soon increased to 8 feet depth. A good channel can be made through the break of this dam by throwing a dam 200 feet long from the west bank, 500 feet above, and parallel to the one already built on this bank. The lower dam should also be lengthened 200 feet. The channel would then be on the east side of the river, until, crossing through the break of the long dam, we would again arrive in deep water, in the old channel above the shoal.

The estimated cost of this improvement is $1,400. The east bank would also have to be protected by a bulk-head of piles and logs. This is estimated at $2,600.

Leaving Chitwood Bar, we pass down the river nine miles, and reach

BEAVER AND LONE TREE RAPIDS.

These two rapids, being only a mile apart, and each of them being shoal, were surveyed as one rapid. That nearest the top of the map is called Beaver Rapids. The average width of the river at and between these rapids is 700 feet; the bed of the river is large coarse gravel. The fall of the river from the head of Lone Tree to the foot of Beaver Rapids, a little over a mile, is 5.6 feet. The observed velocity of the current was 204 feet per minute, but in the shoalest part, between the two gravel-bars, it was swifter.

Between the two rapids the channel is well defined, and contains from 4 to 8 feet of water, but at the rapids it is scarcely 3 feet in depth, and very narrow. Beaver Rapid is navigated without much difficulty, but when in Lone Tree Rapids the boats have to cross the current above the upper gravel-bar, and are liable to be swept broadside against the bar. As the swiftest current and smallest gravel are between the two gravel-bars, I think that the best place for making a channel. This can be properly done by building a dam from the head at gravel-bar No. 2, diagonally across the current to the south shore, 200 feet. This will scour away the small gravel at the foot of bar No. 1. If it does not give a channel sufficiently wide, concentrate the current still more by throwing out a wing-dam from the right bank, 300 feet long, toward the head of bar No. 1. This will deflect the current toward the left bank, and materially assist the lower dam in producing sufficient scour. The estimated cost of the two wing-dams is $1,500.

If the upper dam should be built, it might cause the left bank to wash, which is low and flat, and covered with trees. To prevent this we should have to pile and protect the left bank for a linear distance of 1,000 feet. This it is estimated will cost $5,100.

Four miles below Beaver Rapids we reach

MATHENEY'S BAR,

which is about fifteen miles below Salem, and a place where the boats frequently ground. The river widens to 750 feet, has a velocity of 300 feet per minute, and a gravelly bottom. Two dams have been built here by the company. The upper one was very rudely constructed and was not of sufficient length, and the lower one, though being well constructed, is, I think, improperly located. This shoal might be improved by repairing the old upper dam, and extending it 350 feet further out, as indicated on the map. This would leave a water-way 400 feet wide, and would soon scour out gravel enough to make a good channel. There is no danger of the left bank washing, as it is a coarse gravelly shore.

Immediately below the bar the river becomes from 12 to 15 feet deep. The cost of repairing the old upper dam, and extending it 350 feet, would be $1,200.

RECAPITULATION.

Improving Bower's Bar	$3,500
Improving Humphrey's Bar	700
Improving Chitwood Bar	4,000
Improving Beaver and Lone Tree Bars	6,600
Improving Matheney's Bar	1,200
Total	16,000

The wing-dams, of which the above estimates were made, are of the simplest construction, consisting of logs 2 feet in diameter and long as possible, to be thrown diagonally across the current and held in position by four piles, two at each end of each log; willow brush to be lodged against the upper side, and held in place by gravel. These dams would be equally as good as any of those constructed by the company, and might answer the purpose for which they are intended, viz: temporarily improving the navigation of the river at such bars on which they may be placed. The dams already constructed have benefited the navigation at certain localities; navigation has become more difficult at others, but the injury to other parts of the river is not necessarily to be attributed to the wing-dams.

If the river should be improved at Matheney's Bar, Beaver and Lone Tree Rapids, and Chitwood Bar, the result would be that boats might make the trip from Oregon City to Salem in a few hours less time than at present, and would be able to carry a little more freight. As all the boats plying on this river are owned by one company, it is questionable whether any improvement on these bars, by the Government, would cause any reduction in the freight tariff.

Should the two obstacles above Salem be removed, viz, Humphrey's Rapid and Bower's Bar, boats might get to Albany and Corvallis during low-water stage.

Before closing this report, I wish to thank Assistants Charles F. Brown and S. D. Adair for their valuable services during the survey.

Respectfully submitted.

WM. H. HEUER,
Lieutenant of Engineers.

Major R. S. WILLIAMSON,
United States Engineers.

W 4.

SAN FRANCISCO, CALIFORNIA,
December 12, 1870.

GENERAL: In accordance with the order of the Chief of Engineers, dated Washington, July 23, 1870, placing me "in charge of the survey of the Umpqua River, Oregon, and instructing me to inform myself of the nature and extent of the surveys required, and to submit, at an early day, a project and estimate therefor, having regard to the strictest economy," I have to submit the following report:

A surveying party, consisting of Lieutenant Heuer and three assistants, under my supervision, sailed from here on the 2d of September. Upon our arrival in Oregon, the party was placed in the field, surveying the bars of the Upper Willamette River, while Lieutenant Heuer and I went by stage to Roseburgh, Oregon, with the view of getting information in regard to the Umpqua River. While there, we conversed with parties interested in the navigation of this river, and ascertained that a small stern-wheel steamboat, drawing about 13 inches of water, had, during this year, when the river was about 4 feet above its present low-water stage, ascended the river from Scottsburgh, twenty-five miles from its mouth, to Roseburgh, a distance by the river of about one hundred and twenty miles, but that the river had such a rapid current and so many *obstructions, that* the boat had to be hauled through the rapids by lines, and was six days in getting to Roseburgh. The boat then returned to Scottsburgh. This, I believe, was the only attempt ever made to navigate the river with a steamer.

We intended to examine the river by descending it in a skiff, but ascertained that in some places the river had not sufficient depth of water to float the skiff, and there was then no one in Roseburgh who could pilot us down the river. We therefore hired a wagon, and concluded to go down the river by the wagon-road, which approaches it at many points, and by this means endeavor to obtain material for making a report. After traveling along the river for portions of two days, we arrived at Sawyer's Rapids, a distance of about fifty miles by land from Roseburgh. Here we met Captain Horn, who had piloted the steamboat up the river, who informed us that Sawyer's Rapid was the lowest obstacle to the navigation of the river. The last thirty miles of the journey, the road ran along the river bank, which gave us an opportunity of viewing the river, which we found to have a very rapid current and generally high, steep banks, heavily timbered. The average width of the river when bank-full appeared to be about 200 feet, but at its extreme low-water stage the water is divided at many places into half a dozen or more streams, varying in width from 2 to 30 feet, and separated from each other by walls of rock, sometimes 5 or 6 feet in height. In passing through some of these narrow places the velocity of the current was 400 feet per minute. At each of the rapids between the channel and the shore there is a bench of sand-stone, generally flat, varying from 2 to 5 feet in height above low-water mark, and averaging about 75 feet in width. During ordinary stages of the river, this is covered with water. The river contains no sand-bars, its bottom being coarse gravel or solid bed-rock; consequently any improvements which may be made to the river are likely to be permanent. I shall now endeavor to describe each of the rapids examined, sketches of which are forwarded by this mail, commencing with

SAWYER'S RAPID,

This obstruction is about twelve miles above Scottsburgh, and about a quarter of a mile in length. Here, at high-water stage, the river is about 300 feet wide, but during low water is nowhere over 80 feet, and will not average more than 30 feet in width. The current has a velocity of 400 feet per minute, and the channel is obstructed by rock parallel to the general direction of the current. Between the channel and the banks of the river there is on either side a flat bench of sandstone rock, about 4 feet in height and nearly 100 feet wide. Near the middle of the river are two rocks, sandstone, leaving a channel on each side about 15 feet wide. The upper rock is 40 feet long, 6 feet wide, and 18 inches high, measuring 18½ cubic yards. The lower one is about 20 feet below the upper one, is 28 feet long, 6 feet wide, and about 13 inches high, measuring about 7 cubic yards. The upper one of the two rocks has been partially removed by blasting; it was formerly about 5 feet high. Captain Horn says if these two rocks are removed, navigation on this rapid will be safe, as it will give a channel 30 feet wide in its narrowest part. In the sketch accompanying the report, the rocks are marked A and B. Leaving Sawyer's Rapid, we proceed twelve miles up the river and reach

HART'S RAPID.

Here the bed of the river presents the same general features as at the other rapids. River at low-water stage is about 50 feet wide, with a bench of sandstone rock about 4 feet high, and in some places 150 feet wide, between the channel and shore. Near the lower end of the rapid the channel contracts to about 15 feet in width. By blasting of the point marked A B, which causes this contraction, (rock measures 83 cubic yards,) and a small rock marked C, just below the point, and measuring 9 cubic yards, the obstructions to navigation on this rapid will be removed, and a channel 30 feet wide obtained. At the upper end of the rapid, in mid-channel, is another rock, but at ordinary stages of the river it is said to be about 4 feet under water, and, therefore, not an obstacle to navigation. About fifteen miles by land above Hart's Rapid we find

MILL'S RAPID,

which is claimed to be the worst rapid in the river. It is about three-quarters of a mile in length, and has a channel at low water 25 feet wide, but it is tortuous, made so by points of rock projecting into the channel from the rocky bench on either side. It also has a rapid current, which during high water strikes these points and causes it to deflect to the opposite side of the river, rendering navigation dangerous.

If the three points marked on the sketch A B C, and the two rocks marked D and E, were removed, measuring in all 633 cubic yards, it is thought that all the obstacles to navigation would be overcome.

Nine miles above Mill's Rapid (by land) we find

DELONEY'S RAPID,

where the current has a northwesterly direction, and the channel, where not obstructed by rocks, is about 30 feet wide. The banks on each side of the river are very steep and about 150 feet apart, having a bench of sandstone rock about 3 feet high, and varying in width from 10 to 100 feet between the banks and channel. At the upper end of this rapid, which is about a quarter of a mile long, the channel contracts to about 30 feet in width, and contains in mid channel two rocks, the larger of which is 50 feet long, by 10 feet wide, by 1 foot high, measuring about 19 cubic yards. The smaller rock near it is nearly one-third as large. The river then widens to 100 feet, forming almost a square pool; then contracts again to 30 feet width for a distance of 150 feet. It then widens to 50 feet, and within the next 150 feet contains five ledges of sandstone rock, nearly parallel to the general direction of the current, and varying from 20 to 75 feet in length. The rocks measure 122 cubic yards, all of which it will be necessary to remove in order to get a safe channel.

The next rapid examined is called

CROW'S RAPID,

and is distant from Roseburgh about twelve miles. The channel is nearly 75 feet wide, except just where the obstruction exists, which is a ledge of sandstone rock, about 200 feet long, which contains four pinnacles or lumps of rock, about 40 feet apart, the tops of which are from 2 to 6 feet above the surface of the water. The great mass of this ledge of rock is but a few inches above the surface of the water, and will not require removal, but the four points mentioned above ought to be removed to improve the navigation. This gives a channel 50 feet wide. As the rocks are full of seams and pitches nearly vertically, the lumps can be easily removed.

The five rapids mentioned in the report are all that could be approached by land, and therefore all that we saw. Coptain Horn informs me that there are three other rapids in what is called the cañon, between Crow's and Deloney's Rapids, near Clayton's. The timber and undergrowth was so dense that it was impossible to approach these rapids even on horseback. The captain states that the quantity of rock to be removed from these rapids is less than that of the rapids which we saw. Suppose that the quantity of rock was equal to that of the other rapids, we would in the whole river have only 1,926 cubic yards of rock to remove to render navigation during ordinary stages of the river practicable and, Captain Horn says, good. At Roseburgh the Umpqua River during a freshet has risen 20 feet, but an ordinary stage of the river is said to be about 4 feet above its low-water stage, which continues for about seven months in a year, during which time the river could be navigated, and the boat could take out and bring in all the freight of the Umpqua Valley. This has heretofore been hauled over a bad wagon-road, for hauling which teamsters charged $40 per ton. The exports of the valley for the present year, consisting of wool, bacon, and lard, was 1,000 tons; the imports for the same time, 1,300 tons. The census returns of the valley were not completed when we left, but from the best available information it was reported that the valley contained 1,500 voters. The Umpqua Valley is also said to contain 46 surveyed townships, containing 967,680 acres, of which fully one-third is arable, and the remainder grassy hills and timber lands, mostly oak openings. There is, besides this, a large quantity of unsurveyed land which is suitable for pasturage. The people of the valley claim that if the river is improved, besides it being the outlet for this valley, it will also benefit Rogue River Valley, including Jackson and Josephine Counties, which now wagon their supplies over one hundred and forty miles over a mountain road.

Project and estimate for removing the obstructions to the high-water navigation of the Umpqua River.

The proper time to work on the river would be during August and September, when the river is at its lowest stage. The general plan would be to put a force of men sufficiently large to remove all rocks in any particular rapid during this time. The rock being a soft sandstone, will be easy to drill. As the height of the rocks to be removed is generally less than 4 feet, a small drill, say 1-inch, should be used, and for this reason giant-powder would be preferable to the ordinary blasting-powder. A force of ten men, a blacksmith, and a foreman, can remove the two rocks at Sawyer's Rapid in six days. The same party can then move to Hart's Rapid and remove those two rocks in eighteen days.

At Mill's Rapid I should place twenty men, two blacksmiths and helpers, and one overseer; the obstructions could be removed in thirty days. Then move this same force to Déloney's Rapid, which could be cleared in eight days. Place a force of ten men, one blacksmith and helper, and an overseer, at Crow's Rapid; the work here can be finished in ten days. Send twenty laborers, a blacksmith, helper, and foreman to the rapids in the cañon near Clayton's; and when the party at Crow's Rapid have finished their work, send them to Clayton's, to assist the party there, and it is probable that they can then complete these rapids in thirty days.

Estimate of probable cost of removing the rocks.

Sawyer's Rapid:	
Wages of 10 men, 6 days each, at $3	$180 00
Wages of 1 blacksmith and helper, at $8	48 00
Wages of 1 overseer, at $5	30 00
Tools for drilling: 10 drills, 10 hammers	40 00
1 portable forge	50 00
1 ton coal	20 00
50 pounds giant-powder, at $1.50	75 00
Transportation of men and material	60 00
Total	503 00
Hart's Rapid:	
Transportation of 13 men and material, Sawyer to Hart	$26 00
Wages of 10 men 18 days, at $3	540 00
Wages of 1 blacksmith and helper, at $8	144 00
Wages of overseer, 18 days, at $5	90 00
3 tons coal, at $20	60 00
200 pounds giant-powder, at $1 50	300 00
Total	1,160 00
Mill's Rapid:	
Wages of 20 men, 30 days, at $3	$1,800 00
Wages of 2 blacksmiths and helpers, at $8	690 00
Wages of 1 overseer, at $5	150 00
Tools, drills, hammers, and spoons	100 00
1 forge	50 00
5 tons coal, at $20	100 00
1,200 pounds powder, at $1 50	1,800 00
Transportation men and materials	150 00
Total	4,840 00
Deloney's Rapid:	
Wages of 20 men, 8 days, at $3	$480 00
Wages of 2 blacksmiths and helpers, at $8	128 00
Wages of overseer, at $5	40 00
2 tons coal, at $20	40 00
3[illegible]pounds powder, at $1 50	450 00
Total	1,138 00
Crow's Rapid:	
Wages of 10 men, 10 days, at $3	$300 00
Wages of blacksmith and helper, at $8	80 00
Wages of overseer	50 00
Tools	70 00
Forge	50 00
2 tons coal	40 00
130 pounds powder, at $1 50	195 00
Transportation	30 00
Total	815 00

RECAPITULATION.

Sawyer's	$503 00
Hart's	1,160 00
Mill's	4,840 00
Deloney's	1,138 00
Crow's	815 00
Total	8,456 00
Add 20 per cent. contingencies	1,691 20
Total	10,147 20
Clayton's three rapids	10,147 20
Grand total	20,294 40

This amount is in gold coin; $22,549 33 in currency, at 90 cents.

As a steamboat can certainly carry freight, with improved navigation, from Roseburgh to Scottsburgh at $20 (coin) per ton, the difference or amount saved on imports of the valley alone, for less than one year, will more than pay for the removal of obstruction to the navigation of the river. It is therefore to the interests of the steamboat company as well as to those of the valley to remove the rocks.

Very respectfully, your obedient servant,

R. S. WILLIAMSON,
Major of Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

W 5.

SAN FRANCISCO, *January* 28, 1871.

GENERAL: I have the honor to transmit herewith a report of the survey made under my direction by Lieutenant W. H. Heuer, United States Engineers, of portions of the Sacramento River. The one is of that portion between Rio Vista and the foot of Steamboat Slough; and the other between Sacramento City and Haycock Shoal. The two maps accompanying this report illustrate the character of the river in the parts surveyed. The intermediate portions of the river contain no obstacle to navigation worth mentioning.

The surveys demonstrate that there is 7 feet of water, at the lowest stage of the river, over the most difficult bars, and as it is believed that the amount of freight received on board the boats does not reach the amount necessary to bring them to draw 7 feet of water, there is no real obstacle to the navigation of the river in its present condition. Nevertheless, it appears that there are three points on the river, viz, at Eagle's Nest, Haycock Shoals, and near Sutterville, where, if the river could be deepened without forming shoals elsewhere, it would result that at least 8 feet of water can be carried from Sacramento City to the mouth of the river. It has been shown that the river cannot be improved by dredging. The effect of wing-daming is uncertain, for though in some cases the effect of them has been decidedly beneficial, in other cases bars have been formed which were detrimental to their navigation.

I think, however, that the experiment is well worth trying; and I respectfully recommend an appropriation of $7,500 for the purpose.

I have the honor to be, very respectfully, your obedient servant,

R. S. WILLIAMSON,
Major, United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A.

SAN FRANCISCO, CALIFORNIA, *January* 28, 1871.

MAJOR: In accordance with your order of October 19, 1870, directing me to make a survey of that portion of the Sacramento and Heacock's River between Sacramento and Heacock's Shoals, together with a survey of that part of the river containing the Hog's Back, I started with my party for Sacramento on the following day and there commenced operations, gradually working down the river to below Heacock's Shoals, nine and three-quarter miles below Sacramente. The field-work of this section of the survey was completed on November 4, in twelve working days. We then moved camp to near the Hog's Back obstruction, (about thirty-nine miles below Sacramento,) and made a survey extending from the upper end of the slough containing this obstruction to the head of Gillespie or Wood Island, near the town of Rio Vista, a distance of seven miles. This portion of the survey was completed November 19. The average width of the river between Sacramento and Heacock's Shoal is about 700 feet, its greatest width is 750 feet, and it is narrowest about one and a half miles below Sacramento, where it is only 275 feet wide.

Between Sacramento and Heacock's Shoals the river makes several bends, at each of which the river narrows to about one-half its average width; just above and within 200 yards of the contraction is where the shoals are found. The least depth of water on these shoals, in the channel, is 7 feet, but in the bends we found from 20 to 30 feet depth of water. After leaving the bends the water becomes less deep, averaging about 10 feet.

Some of the river men attribute the formation of these shoals to the placer mining which was carried on in the streams emptying into the Sacramento. Immense quantities of débris would thus be carried down stream and deposited here and there along the bottom of the river.

The deposit or shoal is a mixture of sand and mud, the particles of which were probably held in suspension by the water, and were gradually carried down stream by the force of the current until they reached nearly to these narrow places near the bends, where the velocity of the current was checked and caused the sediment to deposit.

The banks of the river are generally clay, (adobe,) covered with a rich soil, except on the convex side of the bends of the river; there the bank is invariably sand. The banks vary in height from 5 to 25 feet, beyond which the ground is comparatively level for a distance of from twenty to thirty miles, when the country becomes hilly.

At Sacramento the mean observed rise and fall of the tides is about nine inches. The tide gradually increases as we proceed down the river. The extreme observed tide of Hog's Back (thirty-nine miles down the river) was 4½ feet. At Chicory Ranch (four and a half miles below Sacramento) a few current observations were made. It was found that at half-ebb tide the velocity of the surface current was 108 feet per minute, while at half flood the current was 100 feet per minute, thus showing that this far up the river the tides affected the current but little. At the Hog's Back, however, a very different result obtains. There, during a flood tide, the current runs up stream two-thirds as rapidly as it flows down during an ebb tide. From this it would be inferrred that there must be some point between Hog's Back and Sacramento where the tide ceases to produce an up-stream current, and that at or near such place a shoal or bar might be expected. On conversing with the steamboat men on the subject, I found that there were several shoals in that part of the river, but that they did not interfere with its navigation. This is probably due to the fact that after we get above the Hog's Back the river is very much narrower than below. the current being more concentrated, and therefore stronger, would have a tendency to scour away deposits left by the flood tide. About eight miles above the upper end of the Hog's Back the Sacramento River forks. One of these branches is called Steamboat Slough, which is six miles long and not over 200 feet wide, opening at its lower extremity into the slough containing the Hog's Back, which suddenly widens from 200 feet to 600 feet, and in some places to 900 feet in width. The other fork is the Sacramento River proper, and is called Old River. It is wider, shoaler, and larger than the slough. For this reason steamboats do not navigate it. The difference between extreme high and low water of the Sacramento River, at Sacramento, is 24 feet.

The highest known flood of the river occurred in January, 1862, when the river overflowed its banks and presented the appearance of a lake fifty miles in width. To protect the banks from overflow levees have been built along its banks, varying from 3 to 10 feet in height. Near the mouth of the river the floods do not reach nearly so high. The highest observed water-mark was but 12 feet above its low-water stage.

The water of the river is very muddy, which is probably due to the mining on some of its forks. Steamboat men state that fifteen or twenty years ago the water was very clear, and that, at present, it is not so muddy as it was ten years ago; this is also attributed to the decline of placer mining. At Sacramento the river, at low-water stage, is 30.5 feet above the level of the sea, (deduced from a long series of barometric observations by Dr. Logan, of Sacramento.) Its fall is not definitely known, but is supposed to be about 5 inches per mile.

The time of transmittal of the tidal wave from San Francisco to Sacramento (one hundred and twelve miles) is 9.2 hours.

In that portion of the river between Sacramento and Heacock's Shoals a channel is found 8 feet deep and 75 feet wide in its narrowest part, with the exception of but one place, which is two and three-fourths miles below Sacramento, or about three-fifths of a mile above Sutterville; here a bar is found 600 feet across, having only 7 feet depth of water over it, (shown on the map and marked section on E. F.) After leaving this bar we find good water, but the channel again narrows to 75 feet in a bend of the river, near the Chicory Ranch, four and a half miles below Sacramento, after leaving which we again have a good, wide channel, until we arrive at the wing-dam at Heacock's Shoals; here, again, the channel contracts to about 75 feet in width, but it is crooked.

A channel 7 feet deep and 100 feet wide is found from Sacramento to below Heacock's Shoals.

The narrow and crooked channel at this shoal can probably be improved by repairing the wing-dam there. The estimated cost of the repairs is $845. About Suttersville the shoal might be improved by throwing in a wing-dam 700 feet long from the left bank. As the water immediately above and below the proposed wing-dam is only from 9 to 10 feet deep, it is to be feared that the sand, which the dam would cause the current to scour out, would be deposited below, and perhaps form a new bar equally as bad as the one now found.

That portion of the river containing the Hog's Back varies in width from 500 to 900 feet.

The Hog's Back is not a well-defined single bar, but it is a series of shoals, having 7 to 8 feet depth of water between. The distance from the upper to the lower of these shoals is about three and one-half miles. A channel 7 feet deep and 75 feet wide in its narrowest part is found over these shoals. The average width of the 7-foot channel is 200 feet. There is but one of these shoals that contains as little as 7 feet depth of water; it is know as Eagle's Nest, and is 400 feet across. Each of the other shoals have 8 feet of water over them.

The bar at Eagle's Nest can be improved, if necessary, by building a wing-dam 500 feet long from the opposite side of the river, starting near the wood-yard.

DESCRIPTION AND EFFECT OF THE WING-DAMS CONSTRUCTED IN THE SACRAMENTO RIVER.

Of the wing-dams constructed by the California Steam Navigation Company three yet remain; one at Heacock's Shoals, 400 feet long; one at the upper end of Hog's Back Shoal, 400 feet long; and the other one and one-half miles below, which is 1,500 feet long. They are built by driving two parallel rows of piles; rows 6 feet apart, the piles in each row varying from 6 to 8 feet from center to center. The general direction of the dams is diagonally across the current. Between the piles, willow bushes, their butts up stream, are placed and thrown in until the top of the brush is at the level of high tide; they are then kept in place by pieces of board nailed over them, and extending from pile to pile.

The general effect of the wing-dams has been to benefit the navigation over any particular shoal in which they were placed. Before the long wing-dam was built on the Hog's Back boats frequently grounded there, but now that the current has been concentrated a channel 10 feet deep has been made over the worst of the bars. A great portion of the sand washed out was deposited close to the down-stream side of the dam, and has formed a bare bar 1,600 feet long by 250 feet wide.

DREDGING.

Some efforts have been made to improve the navigation of the river at Hog's Back by dredging. Several thousand cubic yards of sand and mud were removed, but as soon as the river began to rise a little the channel which had been dredged out refilled to its old level. The experiment demonstrated that the river could not be improved by dredging.

The steamboats that navigate the Sacramento River are all owned by the California Steam Navigation Company, and are magnificent boats. Numerous sailing vessels also ply between San Francisco and Sacramento. Sailing vessels frequently ground in making the trip, but that is probably due to their inability to keep in the channel. Steamboats do not run aground often. They carry all the freight that offers, and could carry much more than they do during the lowest stage of the river. The president of the company informed me that their boats could carry 600 tons of freight on 7 feet depth of water. To what extent commerce would be benefited by increasing the depth of water by a foot or two in that portion of the river mentioned in this report I cannot say.

To increase the depth, so that vessels drawing more than 8 feet of water could navigate the river during its lowest stage, numerous places between Sacramento and Rio Vista would require improvement at an enormous expense. Wing-dams might improve the navigation in several places, but it is feared that their good effects would be counterbalanced by shoals which they would cause lower down the river.

For all the present demands of commerce the depth of water in the Sacramento River is sufficient.

The following is an estimate of the cost of a wing-dam 500 feet long near Eagle's Nest:

Cost of 128 piles, 30 feet long, at 25 cents per foot	$960 00
Transportation of same from San Francisco to Hog's Back	128 00
Driving 128 piles, at $5 each	640 00
Labor on dam, thirty men ten days, at $2 50 per day	750 00
Contingencies, 10 per cent	247 80
Total cost	2,725 80

This would make the cost about $5 45 per linear foot.

A wing-dam 700 feet long near Sutterville would therefore cost	$3,815 00
Repairing old dam at Heacock's shoals	845 00
Add for proposed dam at Eagle's Nest	2,725 80
Would make a total cost of improving the river at these three localities	7,385 80

The result of the survey is embodied in the two maps which accompany this report.

Very respectfully, your obedient servant,

W. H. HEUER,
Lieutenant of Engineers.

Major R. S. WILLIAMSON,
Engineer Corps, U. S. A., San Francisco, California.

W 6.

SAN FRANCISCO, *July* 21, 1871.

GENERAL: The third section of the act of March 3, 1871, making appropriations for river and harbor improvements, directs an examination or survey at Santa Cruz, California, and by the direction of the Chief of Engineers this work was placed in my charge.

On making inquiries upon this subject, I find that by an act of the legislature of the State of California approved February 11, 1870, a commission was appointed "to examine the harbor of Santa Cruz and Salinas Slough, in the bay of Monterey, for the purpose of ascertaining whether the same or either of them are or can be made suitable for a harbor of refuge, and whether the same or either of them can, by artificial means, be improved." A copy of the report of this commission is hereby appended.

Without going into a discussion of the details of the commissioners' report, it is very apparent that to improve the harbor of Santa Cruz with a view of making it a harbor of refuge, a breakwater similar to the one described by them must be built, and the cost of such a structure will be several millions of dollars.

These facts, I presume, are the main ones upon which information is required by Congress, and the commissioners' report affords all detailed information.

I have the honor of being, very respectfully, your obedient servant,

R. S. WILLIAMSON,
Major, United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

SAN FRANCISCO, CALIFORNIA, *February*, 1870.

His Excellency H. H. HAIGHT,
Governor of California.

The commission appointed by the legislature of this State (chapter 62 of the statutes of 1869 and 1870 of California, approved February 11, 1870) to examine the harbor of Santa Cruz and Salinas Slough, in the bay of Monterey, for the purpose of ascertaining whether the same or either of them are or can be made suitable for a harbor of refuge, and whether the same or either of them can, by artificial means, be improved, has the honor to submit the following report:

The commission first visited the harbor of Santa Cruz. An examination of the harbor from the adjacent shore, together with the Coast Survey chart, clearly indicated that the only method of making this a safe harbor of refuge will be by the construction of a breakwater, and indicates also the approximate position and extent of such a breakwater. This harbor is situated at the northwest portion of the bay of Monterey, and is protected from all winds from the northward, but exposed to the full sweep of southerly gales. The available anchorage is about one and a half miles in length from east to west, and about three-quarters of a mile wide from north to south.

On the next page we annex a sketch of the harbor on a scale of $\frac{1}{20000}$, being twice the size of the original Coast Survey chart. On this sketch we have laid down the approximate position of where we think a breakwater, if one is constructed, should be built. It will be observed from the location which has been chosen that passages for vessels are left around each end of the supposed breakwater; the main entrance to the harbor, however, being between the shore and its eastern end.

It is necessary to provide two entrances or channels, for should either end of the breakwater be joined to the adjacent shore, the currents in the harbor would be checked, and the great quantities of sand brought down by the San Lorenzo River, being no longer carried away by the currents, would be deposited in the quiet waters of the harbor, and fill it up in the course of time.

The breakwater is supposed to be three-quarters of a mile in length. It is believed that this length would protect a harbor of sufficient size for commercial purposes, and at the same time afford protection to all vessels likely to seek shelter here in protracted gales from the south or southwest.

The breakwater, as sketched, would be built in a depth of 6½ fathoms of water at low tide.

The sheltered area available for the anchorage of vessels would be about one-half of a mile wide, from north to south, and about one mile long from east to west, or 320 acres.

Doubtless, if a large harbor was required here for vessels of war as well as commerce, the breakwater should be built from a quarter to a half mile further out, toward Point Santa Cruz; but this would carry it out to 7½ and 8 fathoms of water, at low water, by which the expense of construction would be greatly increased.

There is an abundance of stone, of a suitable quality, for the construction of such a breakwater, both granite and limestone, (or marble,) within about three and a half to four miles of the harbor, and there would be no great natural obstacles to be overcome in the construction of a railroad for its transportation should a breakwater be determined upon.

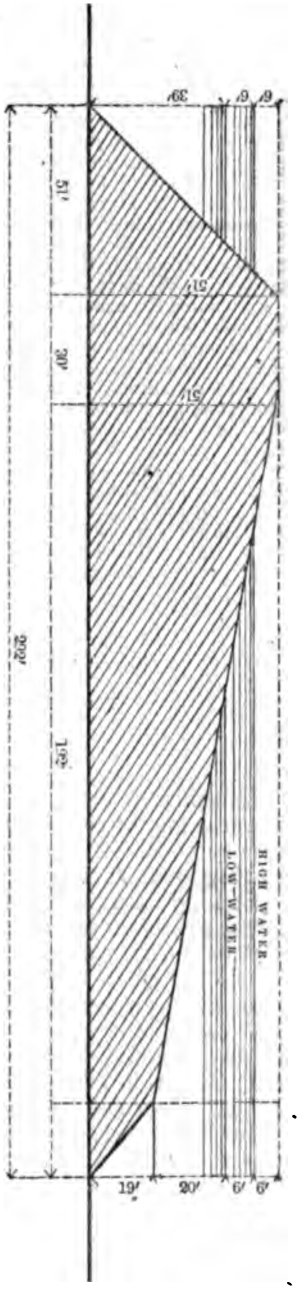
MODE OF CONSTRUCTION.

We would first drive piles from the shore, opposite the west end of the breakwater, as far out as it would be possible to make the piles secure against the force of the waves. Doubtless they could be carried out to 12 feet, and perhaps to 18 feet of water at low water. On these piles we would construct the railroad track for the transportation of the stone. But, as we have before observed, it will be necessary to provide an entrance or water-way into the harbor from the west end. Such an opening would have to be passed by a bridge.

The easiest way to do this would probably be to deposit the stone forming the west end of the breakwater (at A) from vessels, until a cone of heavy stones was raised to a height of about 10 or 15 feet above extreme high water. A strong temporary bridge, some 200 or 250 feet in length, could then be thrown over the opening between this stone pier and the end of the temporary wharf, over which the stone for the remainder of the breakwater could be transported. After the completion of the breakwater, the bridge and pile-work could be removed, and the western passage would then be unobstructed.

As to the cross-section to be given to such a breakwater, we think it should receive the same general form and dimensions as experience in other places has shown to be necessary. We have consulted the elaborate work of Sir John Rennie on "the theory, formation, and construction of British and foreign harbors," and examined, particularly, the construction of the Cherbourg Breakwater, in France, and the Delaware Breakwater, at the mouth of the Delaware River, and we have arrived at the conclusion that a breakwater in the position we have sketched for Santa Cruz Harbor should have a width on top of at least 30 feet that it should rise to a height of at least 6 feet above high water of spring tides; that the inner slope might be 45°, or 1 upon 1; that the outer slope, down to a depth of 20 feet below the low water of spring tides, ought to be 1 upon 6; and below that depth, it might be 1 upon 1.

Supposing the average depth of water to be 6½ fathoms, or 39 feet at low water of spring tides, and that these tides rise to a height of 6 feet, the following would be a cross-section of the breakwater:



SCALE: 1 inch = 50 feet.

The area of the cross-section of such a breakwater would be 9,730 square feet, or 1 foot in length of such a breakwater would contain 9,730 cubic feet, which is equal to 360 cubic yards; and disregarding the void spaces between the stones, (which would be a liberal allowance for the enlargements at the ends of the breakwater and for the stone that might be washed away by storms during the construction,) and allowing two tons to the cubic yard, we have 720 tons of stone for one foot in length of the breakwater. Three-quarters of a mile, or 3,960 feet in length, will therefore require 2,851,200 tons of stone. This is a very large quantity, so large that we have no data, at least on this coast, by which we can arrive at even an approximate estimate of its cost.

To give an idea of the extent of the work, it may be stated that if we suppose three hundred working days to the year, and that we can quarry, transport, and put in place 1,000 tons of stone per day, the construction of the breakwater would occupy nine and one-half years. If we suppose the stone to cost $2 per ton, put in place, the total cost would be $5,702,400.

It ought to be understood that this is only an approximate estimate. It may be too much or it may be too little. A correct estimate could be made only after a careful study, based upon correct data of all details.

While the commission does not feel called upon to express any opinion as to the advisability of the Government undertaking the construction of such a breakwater at Santa Cruz, yet it has no hesitation in stating that some harbors of refuge are much needed on this coast. There is no good, safe harbor of refuge between San Francisco and San Diego to the southward and none between San Francisco and the mouth o the Columbia River to the northward, if indeed the entrance to that river may be called a safe one.

At least two harbors of refuge are wanted on this coast, one to the south and the other to the north of this city; and if their construction is found to be practicable, within any reasonable limit of expense, the best interests of this State, as well as the commercial interests of the whole coast, require that they should be commenced without unnecessary delay.

After completing the examination of the harbor of Santa Cruz, we embarked on the steamer Salinas and visited Salinas Slough. This slough is situated at the most easterly point of Monterey Bay, and is nearly equally distant from Monterey and Santa Cruz. We had a good opportunity to observe the bar at the mouth of this slough, which is also the mouth of the Salinas River.

There is a depth of only about 3 feet of water on the bar at low water, and it is constantly shifting. The channel inside is very narrow and crooked, with but little water in some places.

Our observations here confirmed us in the opinion we had formed from an examination of the Coast Survey chart, that it would be impossible to construct a harbor of refuge at the mouth of this slough on account of the great depth of water.

It is stated in Professor Davidson's Directory of the Pacific Coast, in speaking of the bay of Monterey, that a remarkable submarine valley, similar to that off Point Hueneme, has been discovered, and to some extent traced out, in this bay. The head of the valley is five-eighths of a mile south of the mouth of the Salinas River, and the 20-fathom line is only a quarter of a mile off the beach, the depth increasing to 50 fathoms in the next quarter of a mile.

Of course the construction of a breakwater on the slopes of such a submarine valley may be looked upon as entirely impracticable.

The only improvement that could be hoped for here would be to straighten and deepen the entrance into the slough by contracting its outlet and confining its waters to a fixed channel. The difficulties of forming and maintaining such an entrance into this slough, on account of the light, sandy formation, and the heavy sea on the bar during westerly gales, would be very serious; and we do not know that such an improvement would be practicable, and would not like to pass an opinion on it without a special survey and study, which the limited time at our disposal prevents us from undertaking.

A great quantity of grain and other products find their way over this bar, bad as it is, from the valleys of the Pajaro and Salinas Rivers, and if the bar at the mouth of the slough could be improved it would be a great benefit to those productive valleys.

Respectfully submitted.

B. S. ALEXANDER,
Lieutenant Colonel Engineers, Brevet Brig. Gen., U. S. A.
C. W. LIGHTNER.

W 7.

SAN FRANCISCO, *July* 22, 1871.

GENERAL: The third section of the act of March 3, 1871, making appropriation for river and harbor improvements, directs an examination or survey at Eureka Harbor, California, and by the direction of the Chief of Engineers this work was placed in my charge.

Strictly speaking, there is no such thing as Eureka Harbor. Eureka is the principal one of several towns on the shores of Humboldt Bay, California, and is some six miles from its entrance. Steamers from San Francisco go there twice in a month, and lumber vessels are constantly entering and leaving it, there being several saw-mills on its shores. The bar, like nearly all ocean bars on the Pacific Coast of the United States, is constantly changing. Every severe storm changes the channel; sometimes there are two channels, and sometimes there is but one. In rare cases the channel is so closed that the steamers cannot go out.

In December, 1865, I was obliged to visit the bay, as it had been reported that a severe storm had endangered the foundation of the light-house. A storm arose shortly after I had arrived there, and I was detained a fortnight before the channel was opened sufficiently to allow the steamer to pass out. No vessel enters or leaves the bay without a pilot. Such a bar can never be improved.

The Coast Survey have made an elaborate topographical and hydrographical survey of this bay.

In order to ascertain, if possible, the object of Congress in making this appropriation, I addressed a letter to the Hon. A. A. Sargent, Representative from California, on the subject. To my letter he replied as follows:

> There is a dangerous bar at Eureka Harbor; I desire it surveyed, so that if any permanent work could be constructed to make navigation more safe, an appropriation therefor might be made. It may be that science may suggest no remedy, or one too costly, but that can only be known by inspection.

It is apparent from the above that the object of the appropriation is to improve the entrance to Humboldt Bay, but, from the very nature of the bar at its entrance, I consider this impossible; and that the elaborate charts of the Coast Survey, to be found in the Coast Survey Office in Washington, afford the fullest topographical and hydrographical information concerning it. My duties during the last six or eight years have made it necessary that I should visit it once or more each year, and I am thoroughly acquainted with its peculiarities. Another inspection of it would not, I think, afford me additional information concerning it.

I have the honor to be your obedient servant,

R. S. WILLIAMSON,
Major, United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

W 8.

SAN FRANCISCO, CALIFORNIA,
September 12, 1871.

GENERAL: The undersigned, the members of the board of engineers constituted by virtue of paragraph 1, Special Orders No. 108, from Headquarters Corps of Engineers, Washington, D. C., August 3, 1871, "to consider and report upon the practicability of improving the entrance to Humboldt Bay and Eureka Harbor, California," have the honor to submit the following report:

The Coast Survey chart of Humboldt Bay, together with the well-known nature of the shifting sands forming the bar, and the concurrent testimony of all persons acquainted with it, seem to furnish to this board all the information necessary to enable us to "consider and report" upon the practicability of improving the entrance to it, without a personal examination.

It is our opinion, after mature consideration, that no permanent improvement of the entrance to this harbor is practicable. Further, that any attempt at improvement, by throwing out jettees of stone—*pierres perdues*—or by constructing such jettees in masonry so as to confine the channel of ingress and egress to the harbor within such limits as to secure, at all times, the necessary depth of water for the admission of heavy ships, would only result in disastrous failure; leaving the stones or the disjointed masonry of such jettees scattered over the bar as so many dangerous obstructions.

Were there two jettees of sufficiently powerful construction to withstand the force of the sea properly located and carried out to, say, 10 fathoms water, with their foundations laid so deep as not to be undermined, we have *no doubt* but that their effect would be to improve the entrance to the harbor, till such time as the resulting currents should accumulate another bar outside of the supposed entrance between such structures.

No doubt, however, if it would be in the power of man to construct such jettees; certainly not without imposing a new national debt on the nation undertaking it. We therefore regard it as impracticable.

Humboldt Bay is a fine harbor when vessels have once entered it. It is the best harbor on the Pacific coast between San Francisco Bay and the mouth of the Columbia River. It has an average depth of between 3 and 4 fathoms of water, and affords safe and commodious anchorage for any number of ordinary-sized vessels.

The great drawback to this bay is the difficulty of entering and departing from it. The entrance is exposed to all the prevailing winds and storms, and being merely a break in a long sand-spit, is subject to frequent change.

About one and a quarter miles outside of the entrance is the bar. This is also subject to constant change both in position and in the depth of water upon it.

In looking over the law of Congress on this subject we notice that the phraseology does not refer to the "improvement of the entrance" to this harbor. And in conversation with Mr. James T. Ryan, a prominent citizen of Eureka, we learn that it has never been expected or hoped by the pilots of Humboldt Bay, or by the well-informed citizens of the vicinity, that anything can ever be done by the Government to improve the entrance.

Further, the Hon. James A. Johnson, the late member of Congress from that district, who was instrumental in having the harbor of Eureka inserted in the act of Congress above mentioned, informed the senior member of this board that he never had any expectation that the entrance to the harbor could be improved. He added that it had been represented to him that additional aids to commerce, such as another buoy on the bar and movable range-lights or beacons placed on shore, to point out to the pilots the exact position of the changing bar, would assist in facilitating access to and egress from the harbor, and that his motive in having Eureka Harbor named in the connection in which it appears in the act of Congress was the hope that something might be done toward furnishing additional guides to vessels seeking to enter the harbor.

As this is a question properly belonging to the Light-House Board, and as it is not embraced in the instructions of the Chief of Engineers, we do not feel ourselves called upon to volunteer an opinion on the subject.

Respectfully submitted.

R. S. WILLIAMSON,
Major United States Engineers.
C. SEAFORTH STEWART,
Lieutenant Colonel Engineers.
B. S. ALEXANDER,
Lieutenant Colonel Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

W 9.

SAN FRANCISCO, *April* 25, 1871.

GENERAL: I have the honor to submit to you the following detailed report upon the removal of Blossom Rock, in this harbor. It may properly be called the history of the work, as in it are described the preliminary steps taken which resulted in a contract made between Mr. A. W. Von Schmidt and the United States, and a description of the operations under that contract. The contractor was not interfered with, and all deviations from the original plan which he thought necessary were consented to by me. My assistant, Lieutenant W. H. Heuer, United States engineers, and myself, acted as supervising engineers from the day the contract was signed until the completion of the work, and this report is the result of our joint labors.

With it are submitted eleven sheets of drawings to illustrate it, as without them it would be exceedingly difficult to give an intelligible description of the machinery used, and the operations conducted.

As the work was of a novel character, and of considerable magnitude, I think the description of it will prove of great interest to engineers in general. If so, I respectfully request that authority be obtained to have it, with the drawings, published; the form to be in quarto, uniform with No. 15 of the Professional Papers of the Corps of Engineers, so that none of the plates will require folding, except Plate I, which will require one fold.

I have the honor to be, very respectfully, your obedient servant,

R. S. WILLIAMSON,
Major United States Engineers.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D.C.

REMOVAL OF BLOSSOM ROCK, IN SAN FRANCISCO HARBOR, CALIFORNIA

This rock was situated in San Francisco Bay, directly east of the Golden Gate, or entrance to the bay, due north of the city, on a line between Alcatraz and Yerba Buena Islands, and nearly midway between them. It was distant from the city front about 1,500 yards. It was directly in the course vessels are often compelled to take in entering and leaving the harbor, was in the track of naval vessels passing to and from San Francisco and Mare Island navy-yard, and was also in the way of all passenger steamers and vessels plying between San Francisco and the Sacramento and San Joaquin Rivers. The rock was discovered and named, in 1826, by Captain Beechey, royal navy, F. R. S., who entered San Francisco Harbor in command of Her Britannic Majesty's ship the Blossom.

The top of the rock was about 5 feet below the surface of the water at mean low tide. Its greatest length at the depth of 24 feet was 195 feet, and its greatest breadth at the same depth was 105 feet. The quantity of rock to be removed to obtain a depth of 24 feet of water was 5,000 cubic yards. A portion of the top of the rock, about 34 by 22 feet in size, was comparatively level, but two of its opposite sides sloped off quite rapidly into deep water. The place is exposed to southeast gales, which prevail here in the winter months, and the tide whirls over the rock at such a rapid rate that the buoy which the Light-House Department placed there has several times been swept away.

CHARACTER OF THE ROCK.

The rock was a metamorphic sandstone of a variable degree of hardness, of a brownish-yellow color, of irregular stratification, and in some places contained small beds of gravel cemented together with a bluish substance resembling clay.

The specific gravity of the great mass of the rock was 2.64, a cubic foot of it weighing 165 pounds, and was so soft as not to require blasting, but in some places it had a bluish tinge, and was as hard as granite.

In August, 1866, my attention was called to Blossom Rock by the following orders:

"ENGINEER DEPARTMENT,
"*Washington, D. C., July* 21, 1866.

"COLONEL: In addition to your present duties, you are assigned to the charge of the following-named works: * * * *

"*Survey or examination* at San Francisco, California, with the view of the removal *of Blossom and Rincon* Rocks, by blasting. * * *

"You will take measures for the commencement of these works with the least practicable delay, using your best judgment as to the most expeditious method of prosecuting the same.

"Respectfully, your obedient servant,

"RICHARD DELAFIELD,
"*Brevet Major General and Chief Engineer, U. S. A.*

"Brevet Lieutenant Colonel R. S. WILLIAMSON, U. S. A.,
"*Major of Engineers, San Francisco, California.*"

"ENGINEER DEPARTMENT,
"*Washington, November* 27, 1866.

"COLONEL: * * * The Department will direct the insulated wire to be sent you from New York, in order that experiments may be made on Blossom Rock, similar to those made on Rincon Rock. This seems to be necessary in order to establish the character of the former, and to enable you to form an accurate estimate of the amount required for its removal. * * * * *

"Very respectfully, your obedient servant,

"A. A. HUMPHREYS,
"*Chief of Engineers, Brigadier and Brevet Major General, U. S. A.*

"Brevet Lieutenant Colonel R. S. WILLIAMSON, U. S. A.,
"*Major of Engineers, San Francisco, California.*"

Accordingly, through the kindness of the Superintendent of the United States Coast Survey, the late Edward Cordell, Assistant United States Coast Survey, who was in command of a surveying party on the Coast Survey schooner Marcy, was authorized to make a survey of Blossom Rock. Experiments in blasting were then made on the rock by my assistant, Lieutenant W. H. Heuer, United States Engineers, under my directions, in February and March, 1867. The following is a copy of his report:

'SAN FRANCISCO, *March* 28, 1867.

"SIR: I have the honor to make the following report in regard to the late experiments on Blossom Rock.

"Blossom Rock is a sandstone, rather hard; is on a line with Alcatraz and Yerba Buena Islands, and about midway between them. When the tides are lowest, the rock has about 5 feet of water over it. A horizontal section of the rock, 18 feet below the surface of the water at mean low tide, gives the greatest length of the rock 130 feet, by a width of 75 feet; to obtain a depth of 18 feet of water at mean low tide would require the removal of 1,000 cubic yards of stone.

"The experiments were made with gunpowder, with the view of estimating the cost of removal of the rock. The charges of powder used were of three sizes, viz, 75 pounds, 125 pounds, and 175 pounds, in order to enable us to ascertain which sized charge would prove most effectual, due regard being had to economy. Each charge was placed in a strong water-tight cask, in the head of which a small hole was bored to admit of the passage of the wire for exploding the charge. The cartridge was placed as near to the middle of the charge as possible. Each cask was inserted in a sack of sail-cloth, which fitted closely, and which was afterward tarred. Two heavy pieces of iron where then tied to each cask, (one on each side,) to prevent the tide from washing the charge off the rock. Soundings were then made to enable us to find advantageous positions for the charge; a small scow was securely anchored over the spot, charge lowered to its place, scow hauled about 200 feet away, the two extremities of the insulated wire placed in contact with the poles of a 12-cup Grove's battery, and the charge immediately exploded; the scow was then hauled back to its first position, and soundings were made, by which we ascertained approximately the effect of the blast. The blasts generally took place at high tide, as then we had the greatest pressure of water on each charge. On the succeeding low water the officers of the Coast Survey (Edward Cordell, Assistant United States Coast Survey, and his assistants) would make an instrumental survey of the rock in the immediate vicinity of the blast, and thus we ascertained quite accurately the results. The officers of the Coast Survey who made the soundings before and after the blasts deserve great credit for the admirable manner in which their work was done, and to their persevering efforts much of the success of these experiments is due. Appended will be found the sketches furnished by Mr. Cordell relative to the experiments. [See Plates II and III.] Owing to the stormy weather, the experiments occupied nearly two months, although advantage was taken of every favorable day during that time, but frequently, after a blast had been made, the bay would be too rough for days, and even weeks, to make an accurate survey, all of which retarded our progress. Before we commenced blasting, an examination of the Coast Survey chart indicated quite a crevice at or near one end of the rock; as it appeared favorable to place a charge there, instructions were given to place a charge of 75 pounds of powder in the crevice. This was on the 29th of January. After they thought they had found the crevice, the charge was exploded in sixteen feet of water. The rock was considerably shattered, but no large masses were broken off, and a subsequent examination proved that there was no crevice there. The second experiment took place on January 30, when 175 pounds of powder were exploded on top of the rock in 11 feet of water. The explosion shattered the rock, but did not materially increase the depth of water. It was then determined to have an examination of the rock made by a diver in armor. He reported that the rock was broken considerably where the two blasts had taken place, that no large fissures had been made, and that the rock was quite jagged in many places. He brought up an armful of specimens of the rock which we had broken up.

"*Third experiment, February* 9.—One hundred and seventy-five pounds of powder were placed, near the west end of the rock, in 14 feet of water, and exploded. Water was thrown to the height of 40 feet, and the survey indicated that about 11 cubic yards of stone had been removed.

"*Fourth experiment, February* 19.—Two blasts, of 125 pounds each, were exploded in succession in 20 feet of water. About 15 cubic yards of material were removed.

"*Fifth experiment, February* 20.—Two charges, of 125 pounds each, were exploded in succession, one in 18 feet, the other in 21 feet of water. Only about 3 cubic yards of stone were removed. It is believed that these charges were placed on loose rock that had accumulated from previous explosions, which these two blasts broke into smaller fragments, and did much less damage than would have resulted had they been placed on solid rock.

"*Sixth experiment, March* 4 *and* 5.—Two charges, of 75 pounds each, were exploded in 21 feet of water. Very little damage done.

"*Seventh experiment, March* 6.—Two charges, of 125 pounds each, were exploded in 16 feet of water. Twelve cubic yards of stone were removed.

"*Eighth experiment, March* 7.—The remaining charge of 175 pounds of powder was exploded in 13 feet of water. A large volume of water, probably 50 feet in height and nearly as much in diameter, was thrown up. The survey showed that 8.5 cubic yards of stone had been removed.

"The experiments just made show that the charges of 175 pounds of powder produced the best results, averaging about 6.17 cubic yards per blast. The 125-pound charges averaged about 5 cubic yards per blast, while the 75-pound charges produced but little effect. It is thought that much loose rock remained where the blasting occurred, which, had it been removed, would have increased the average somewhat, probably 30 per cent. I am also inclined to think that much better results would have been obtained had we used strong iron vessels to contain the powder, instead of wooden casks.

"Number of charges of powder used	12
"Number of experiments	8
"Number of yards of stone removed	49.5
"Total expense incurred, including use of surveying vessel Marcy, officers, and crew	$3,417 42
"Average cost of removal per cubic yard	69 05
"Cost of removing Blossom Rock, at this rate, to a depth of 18 feet of water, (mean low tide)	69,050 00

"The above amount would be the cost of removing the rock to this depth, if we could continually average a pressure of 18 feet of water on each charge, but when the pressure is less, which necessarily follows as we approach the top of the rock, the expense per cubic yard increases rapidly, and, judging from experiments one and two, I think that twice the above amount, or $138,100, would not be too large an estimate. To obtain a depth of 25 feet of water (mean low tide) would require the removal of 3,345 additional cubic yards of stone, which, at an average cost of $69 05 per cubic yard, would make the cost of the additional 7 feet of depth $230,972 25, or, for the removal of the whole rock to a depth of 25 feet, (mean low tide,) a cost of $300,022 25.

"A few suggestions might not be out of place here. If Blossom Rock must be removed, I think it can be done more economically by drilling, and afterward by surface blasting, than by surface blasting alone. But, as the tide is very strong over the rock, drilling might at first be considered rather a difficult matter. This can easily be overcome by building a frame-work of timber and iron, setting it on the rock where we wish to drill, placing a portable 4-inch cylinder engine on top of the frame, drilling with the engine to the required depth, inserting the charge, (nitro-glycerine or powder,) removing the frame, and exploding the charge by means of a battery. After sufficient rock has been removed in this way to enable us to have a depth of 18 feet of water at high tide, then surface blasting can be advantageously used.

"*Estimated cost of removal of Blossom Rock, in this manner, to a depth of 25 feet of water, (low tide.)*

"Cost of engine, sliding boxes, pipe, &c	$2,173 50
"Schooner for powder and quarters for men, (one year)	3,000 00
"Scow	1,500 00
"Engineer, (one year)	3,600 00
"Four laborers, at $150 per month, (one year)	7,200 00
"Overseer	3,600 00
"Powder, 90,000 pounds, at $229 50 per 1,000 pounds	20,655 00
"Cannisters for containing same	6,000 00
"Coal for engine	4,000 00
"Rope and tackle	3,000 00
"Battery	500 00
"Repairs for the year	1,000 00
"Total	56,228 50

"Respectfully submitted.

"W. H. HEUER,
"*Lieutenant of Engineers*

"Brevet Lieutenant Colonel R. S. WILLIAMSON, U. S. A.,
"*Major of Engineers.*"

In 1868 an allotment of $50,000, from the general appropriation for improvements of rivers and harbors, was made for this work. In October, 1868, Brevet Brigadier General B. S. Alexander, United States Engineers, sent in the following project for the removal of the rock, with letter of transmission:

"SAN FRANCISCO, CALIFORNIA, *October* 3, 1868.

"COLONEL: Since the passage of an appropriation by Congress for the removal of Blossom Rock, in this harbor, I have been thinking, from time to time, as to the most practical way of getting rid of that rock; and, having arrived at a conclusion on the subject, which is satisfactory to my own mind, I venture, inasmuch as it differs from the process usually followed, to communicate it to you for your information.

"I understand that you are charged with the execution of this work, but, when I assure you that I have no desire to interfere in any manner with your duties, I feel confident that the assurance, taken in connection with our personal relations, will relieve me, in your mind, from any other wish in the matter than to see this work prosecuted to completion in the cheapest and speediest manner. I therefore send you, without apology, a sketch which will explain my ideas on the subject, together with a description of the proposed operations.

"Having had considerable experience in such matters, particularly in building a coffer-dam around the site of Fort Richmond, Staten Island, when that fort was commenced, I will add that I have no doubt of the entire practicability of putting the proposed dam on Blossom Rock in the manner proposed, nor have I any doubt but that it may easily be made practically water-tight.

"It then becomes a question of sinking a shaft and tunneling under the rock. There will be no trouble in the operation if the rock itself will keep out the water. On this point it is impossible to pronounce judgment before investigation. If the rock is like that at Lime Point, or at Angel Island, or at Alcatraz, Yerba Buena, or Point San José, the leakage into the tunnels will be small, and but little pumping will be required. There can be no doubt if these tunnels can be made without lining, that this will be the cheapest and most expeditious way of removing the rock.

"Should it be found, however, (of which I have little fear,) that the tunnels cannot be made as I have designed them, I think you would find such a dam as that proposed of great assistance, whatever plan of operations you might then be forced to adopt. It would give you a *fixed point* on the rock, which will be the first requisite in enabling holes to be drilled into the rock. If you undertake to drill for blasting, I think you will find a fixed point for your drills absolutely necessary.

"Again, the coffer-dam would enable you to build a barrack and blacksmith's shop upon it, where the workmen could live and be always on hand to take advantage of good weather and favorable tides; saving thereby to a great extent the expense of vessels for the transportation of workmen and tools.

"I have not attempted to make the sketch or the description in such minute detail as will be necessary before commencing such operations. All I proposed to do was to present a plan in outline, to show the practicability of such an undertaking, with such hints as would serve as an indication of the course to be followed.

"I do not propose for you to adopt the plan I have suggested on my responsibility.

In an undertaking of this sort, where there is a possibility of failure, it is proper that the mode of proceeding should receive full investigation, and then the Engineer Department should assume the responsibility for whatever plan may be finally adopted.

"While, therefore, I do not hesitate to say that if I were charged with the removal of Blossom Rock I would urge the department to sanction the plan I have prepared for that purpose, all I can ask of you is that you will forward this plan, with the written description and a copy of this letter, to the Chief of Engineers, for his information.

"Very respectfully, your obedient servant

"B. S. ALEXANDER,
"*Lieutenant Colonel of Engineers, Bvt. Brig. Gen'l, U. S. A.*

'Colonel R. S. WILLIAMSON,
"*Corps of Engineers, U. S. A., San Francisco, California.*"

The following is the project of General Alexander:

"BLOSSOM ROCK.

"This is a sunken rock in the harbor of San Francisco, with about 5 feet of water upon it at low water.

"It is situated a little over three-quarters of a mile from the city front, and is in the track of vessels approaching the city from the ocean, or in going to sea, and is directly in the way of vessels running to and from the Sacramento and San Joaquin Rivers.

"The length of the rock above the level, which would give 24 feet of water over it at low water, is about 180 feet. Its breadth above this level is about 100 feet.

"The removal of so large a rock by surface blasting will, I fear, be a long as well as an expensive undertaking. After a good deal of reflection on the subject, I have arrived at the conclusion that it may be done in a single season, and at greatly reduced cost, by undermining the rock, making a number of powder chambers under it, and blowing the whole rock to pieces at a single operation.

"To do this, I propose to inclose a small surface of the rock by a water-tight coffer-dam; in this space to sink a rectangular shaft, about 4 feet by 9 feet, which is the size I have seen in coal-mines; from the bottom of this shaft to run tunnels and make powder chambers in such positions that when exploded the whole rock down to the level of 24 feet below the level of low water will be lifted in the air and shivered to pieces.

"DESCRIPTION OF THE PROPOSED OPERATIONS.

"I propose in the first place to blast off a small portion of the top of the rock, by what we call surface blasting, down to about the reference of 10 feet, or 10 feet below low water. This is for the purpose of furnishing a comparatively level surface upon which to build a coffer-dam. This blasting operation will consist in lowering down charges of from 100 to 300 pounds of gunpowder to the surface of the rock over the part to be removed in water-tight vessels, and exploding them by means of Beardslee's magneto-electric machine, and afterward removing the shattered portions of the rock by men in armor.

"It will not be necessary to try to get a smooth surface. All that is necessary is to get a surface upon which the coffer-dam will stand. (See Figs. 1, 2, and 3, Plate IV.)

"This operation will be a little tedious, but will not be very expensive, as the quantity of rock to be removed is small, and but few men will be employed in it.

"There is no doubt of its entire practicability. In fact, it is believed that the whole rock, to any required depth, might be removed by this process, the only objection being the great cost.

"It is probable that nitro-glycerine or giant powder, owing to their powerful local effects in shattering, would prove a more efficient agent for this surface blasting than gunpowder.

"This being done, I propose to frame a strong coffer-dam of 12 inches square timber, as shown in Figs. 1, 2, and 3, Plate V.

"This may be built on shore and made water-tight. It should be built up so as to be 13 feet high before launching.

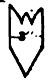
"It will then, if built of Oregon pine, draw about 10 feet of water, and may be easily towed out and anchored over the spot where it is to be placed.

"It will then just ground on the rock at low water, and by the aid of ballast, say bags of sand placed upon platforms or otherwise fastened to the dam, be prevented from floating as the tide rises.

"If it does not ground in exactly the right place at the first trial, the bags of sand may be removed, when it will float again, and its position may then be altered at the next low water. A sufficient number of mooring-buoys will have to be placed around the rock during this operation to enable the coffer-dam to be drawn exactly into the required position.

"When it has been finally placed, it may be loaded with sand-bags or other ballast spiked to the sides, or piled on temporary platforms so arranged as to be easily removed afterward, and the construction completed by carrying it up to the required height, say to the reference 10 feet, or 5 feet above high water.

"Having got it built, I would next plank it over, and load it down securely with ballast, taking care to leave man-holes in each of its ten compartments. I would then put down sheeting piles both outside and inside of the dam. I have supposed them to be 3 inches thick and rather narrow—say 9 inches wide.

"It is not supposed that these sheet-piles can be driven into the rock, but by cutting the lower ends to a feather-edge, thus:  they may be driven down until the lower ends crush into the crevices of the rock, stopping, to a great extent, the flow of water under the dam.

"I have supposed that there are two rows of these sheeting-piles both outside and inside. The second row may or may not be necessary.

"These piles should be bored beforehand to receive several 6-inch spikes, and after each pile has been securely placed against the dam, and against the sheet-pile last driven, a man in armor should go down and drive the spikes, so as to hold it in position.

"This being completed, the next operation will be to fill up the inside of the dam so as to make it water-tight.

"I have supposed that we will use concrete placed in bags to fill it up to the low-water level, though it is altogether likely some cheaper material may be found to answer.

"If bags of concrete are used, they should be about half filled, and of such a size as not to weigh more than 50 or 75 pounds when immersed in the water. When ready to be put in place, a man in armor would go down into one of the compartments of the dam and place them in the crevices of the rock, taking care to fill up solidly the spaces under the timbers, particularly below the timbers which connect the inside with the outside walls of the dam, under which there would otherwise be leakage.

"To give room for this operation it might be better to frame these lower timbers, say 6 inches above the bottom of the outer and inner timbers, though they are not so represented in the drawing.

"Having these spaces under the timbers securely filled, all the man down there would have to do would be to kick the concrete bags into place and walk over them as they were lowered down until the compartment was filled.

"The concrete, if made of good cement, would soon harden, and the cement would come through the bags so as to unite them and make a water-tight mass.

"I would recommend that this concrete be placed in layers of about 2 feet in thickness, carrying it up a layer of about that thickness each day.

"The concrete being all in position, the upper portion of the dam is to be filled up with clay or some other water-tight material.

"The middle compartment of the dam is to be kept open, and it is supposed, when the dam has been finished in the manner described, that this compartment will be practically water-tight. All that is necessary, therefore, to reach the surface of the rock within this space will be to pump the water out of it.

"If the dam is found now not to be entirely water-tight, it may easily be made so by calking between the inside sheeting-piles, and between their lower ends and the surface of the rock.

"We are now prepared to sink into the rock. I have supposed it to be 4 feet by 9 feet in the clear, leaving a ledge of 12 inches between its edges and the face of the sheeting-piles on the inside.

"I suppose that this shaft will be sunk so that its bottom will be in the reference of 36 feet, and at this level small tunnels will be run under the rock, as shown in plan, in Fig. 1, and in Figs. 2 and 3, of Plate IV.

"At the ends of and in these tunnels 55 separate chambers for powder will be placed, as shown in plan, and connected by insulated wires with the battery or machine for exploding them; water will then be admitted through the sluice for tamping, and the whole space filled, pumping water into the middle compartment until it is filled to the top, or reference of 10 feet.

"The mines may be fired simultaneously by the use of about three of Beardslee's machines.

"In consequence of the great depth of the charges, I would recommend that the explosion take place at low water. I propose so to adjust the charges in the chambers that all the rock above the reference of 24 feet will be blown up, shattered, and broken to pieces.

"Much of it will fall back again, but the currents will rapidly remove a great part of it, and the remainder may then be scraped off into deep water, sending down men in armor, when necessary, to fasten to pieces that may prove too heavy to be scraped off.

"The quantity of powder that would be necessary to lift the rock and the water above the mines would be about 13,000 pounds; but, as it will be desirable not only to lift the rock, but to break it up into small pieces, and blow it away as much as possible, I would recommend that about double this quantity of powder be used—say 26,000 pounds—the quantity of powder in each chamber being proportioned to the weight it will have to lift, or to the work it will have to do.

"ESTIMATED COST.

"Blasting off and removing top of rock to receive the coffer-dam, 150 cubic yards, at $40	$6,000 00
"Building coffer-dam, 61,500 feet of timber, at $40 per M, including workmanship and materials	2,460 00
"Cost of placing frame-work in position, say	1,000 00
"Cost of sheeting-piles, 20,300 feet, board measure, at $40, including spikes.	812 00
"Cost of placing the same, say $1 per piece	452 00
"Cost of concrete, 200 cubic yards, at $15	3,000 00
"Cost of clay filling, 200 cubic yards, at $3	600 00
"Cost of planking over the dam, joints, and covering, 5,000 feet, at $40 per M	200 00
"Cost of shaft, with enlargement at bottom, 40 cubic yards, at $10	400 00
"Cost of tunnels and powder-chambers, 778 running feet, at $15	11,670 00
"Cost of powder, say 26,000 pounds, at 10 cents	2,600 00
"Cost of 55 packages and placing the same, at $20	1,100 00
"Cost of engine for pumping and hoisting	2,000 00
"Cost of pump and fixtures	1,000 00
"Cost of derrick and rigging	1,000 00
"Add for contingencies, including barrack and smith's shop over the dam, use of boats, superintendence, and unforeseen expenses, say 20 per cent	6,838 00
"Total, (in coin)	41,132 00

"I do not make any estimate of the cost of removing the broken rock after it has been blown to pieces, because it is impossible beforehand to tell what operations will be necessary in order to accomplish this object. If the rock is anything like that at Lime Point, and if it is shattered like the blasts there have shattered that rock, the currents, in the course of a year, would remove the greater portion of it; but if it should be a stronger rock, and come out in larger masses, it would have to be removed by mechanical operations, and at considerable cost, which, however, would be far less by having the whole rock blown to pieces down to the required depth, than would be the case if the rock had to be blown up by piece-meal, involving a removal of the débris after each successive series of blasts."

"B. S. ALEXANDER,
"*Lieutenant Colonel of Engineers, Brevet Brigadier General, U. S. A.*"

"SAN FRANCISCO, CALIFORNIA, *October* 3, 1868."

In November following Mr. A. W. Von Schmidt sent in a project, as follows:

"SAN FRANCISCO, CALIFORNIA,
"*November* 20, 1868.

"SIR: I have the honor to submit herewith a plan for the removal of Blossom Rock, together with a description of doing the work.

"I will remove the said rock, in accordance with the plan as proposed by me, in the space of eighteen months from the time of signing the contract, for the sum of $75,000, currency of the United States, giving such bonds as shall be required for the faithful performance of the work.

"Yours, respectfully,

"A. W. VON SCHMIDT.

"Lieutenant Colonel R. S. WILLIAMSON, U. S. A.,
"*Major of Engineers.*"

The following is the project of Mr. Von Schmidt:

"SAN FRANCISCO, *November* 20, 1868.

"SIR: I have the honor to submit to you a plan and descriptive specifications for the removal of Blossom Rock, in the harbor of San Francisco, California.

"Blossom Rock, so called, is a sunken rock so well known that I consider a description of its locality unnecessary for these specifications, and shall therefore proceed with explaining my plan for removing the same, reference being made to the annexed plan, in which Plate VI represents the mode and manner of constructing the necessary machinery for working out the interior of the rock. Fig. 1 represents a longitudinal section of the rock. Fig. 2 represents transverse sections of the rock, as shown on the plat of survey made by Edward Cordell, Assistant United States Coast Survey, February, 1867.

"The first object in view is a thorough removal of the rock, so that vessels drawing 24 feet of water will be able to pass over the same at low tide. To accomplish this, the mere blasting and breaking up of the rock would not, in my estimation, accomplish the desired object, as the rock, in broken masses, would still form an obstruction to the navigation of the harbor. I have, therefore, matured a plan by which the entire rock itself shall be excavated in chambers, as shown by Plate VI, Figs. 1 and 2.

"The rock taken out of the interior compartments will be removed through a shaft, and discharged into deep water alongside the rock. When the whole inside of the rock shall have been removed, I propose, finally, to blast the crust over the chambers, and drop the same to the bottom of the excavation.

"To accomplish this, the following mechanical operations will be necessary. I make my lodgement on the highest part of the rock, which is nearly or quite level at this point, being 5 feet under the low-water line, and having a sufficient area for the works necessary to be constructed. I moor a scow for working purposes in the position required. I then place a boiler-iron case, 9 feet in diameter and 13 feet high, with flanges on the lower end, on top of the rock. This flange has a canvas apron, 3 feet wide, running entirely around it and lying on the rock. I then place a lot of sand-bags on top of the canvas apron and around the case. To secure the case I use 1¼-inch round iron rods, the ends of which are firmly secured into the rock by Lewis holes. Turnbuckles are also placed on each rod for the purpose of tightening them up from all sides. After this has been done I pump out all the water there is in this case and make an excavation into the rock, downward, for the purpose of erecting the main case, which is of boiler-iron, 6 feet in diameter and 17 feet in height. This is set within the outside casing, and also firmly set into the rock and secured with anchor-bolts in the same manner as in the first case.

"After this is done I fill all the cracks between the casing and the rock with Roman cement, excluding the water from the interior iron casing.

"When it is found that the leakage has been thoroughly stopped, and the platform erected, as shown in the plan, I commence sinking a shaft down through and into the main body of the rock to the depth required, at which point I place a pump for removing such water as may be encountered in carrying on the work. From the bottom of the shaft I commence tunneling the rock in all directions. As fast as the rock is worked it is brought to the center shaft, through the different tunnels, and placed in a tub, when it is hoisted by steam and discharged alongside the rock, into deep water, by means of a swinging derrick.

"The rock that will remain between the excavation and the water will be about 6 feet in thickness, supported by pillars 4 feet square, and 10 feet apart from center to center. It is proposed to remove most of these pillars when the rock shall have been tunneled, and to set up in their place wooden supports as often as may be required to sustain the weight overhead.

"When the entire mass of rock shall have been excavated, the work will be in readiness to receive the several packages of powder in such quantities as shall be thought necessary, the wires being laid to the several torpedoes and connecting with a magnetic battery placed in a vessel near by. The chamber is to be filled with water, and the torpedoes fired by the battery simultaneously, when it is supposed that the entire shell of rock will be broken into small pieces and precipitated to the bottom, the timber supports floating out, and the work completed in all its details.

"All of which is most respectfully submitted.

"A. W. VON SCHMIDT,
"*Civil Engineer.*

"Lieutenant Colonel R. S. WILLIAMSON, *U. S. A.*,
"*Major of Engineers.*"

These projects, together with their drawings, were sent to the Chief of Engineers at Washington, and $30,000 additional money was asked for to secure the removal of the rock. In February, 1869, I was directed to advertise for proposals for removing the rock, although at the time there was but $50,000 available for its removal.

The following advertisement was therefore inserted in several prominent newspapers:

"PROPOSALS FOR REMOVING BLOSSOM ROCK.

"Sealed proposals in duplicate will be received by the undersigned at his office, 509 Kearney street, San Francisco, California, until 12 o'clock noon, April 15, 1869, when they will be opened, and bidders are invited to be present, for the removal of Blossom Rock, in San Francisco Harbor, California, to a depth of 24 feet at mean low tide, which is the zero of the Coast Survey map of this harbor. In case any of the bids should exceed forty-five thousand ($45,000) dollars in currency, bidders must state to what depth they will remove the rock for forty-five thousand ($45,000) dollars currency.

"All bids are to be made in United States currency, and the payment to be made on the satisfactory completion of the work, after examination by the undersigned or other authorized agent of the Government.

"Each bidder will be required, before the time fixed for the opening of the bids, to file in this office a bond, with sufficient sureties, in the sum of five thousand ($5,000) dollars, conditioned that if his bid is accepted he will execute a written agreement for the faithful performance of his contract, and give such further bond for the faithful performance of his written agreement as may be required, said agreement to be made subject to the approval of the Chief of Engineers, United States Army.

"The contract will be awarded to the lowest responsible bidder, but the right to reject any or all of the bids is reserved.

"A copy of this advertisement must be attached to each bid.

"Bids that do not comply with the above requirements will not be entertained.

"Plans and sections of the rock, copied from the Coast Survey chart, may be seen at my office.

"Persons who wish to bid for the work, and who reside at a distance, can be furnished with copies of said plans and sections by applying at this office.

"R. S. WILLIAMSON,
Brevet Lieutenant Colonel, U. S. A., Major of Engineers."

In reply to the advertisement, only one bid was received, which was from Mr. George W. Townsend, of Boston, Massachusetts, who offered to remove 900 cubic yards of rock from Blossom Rock for $45,000, which he estimated would leave the upper surface of the rock level and 15 feet below mean low water. We estimated that the removal of 900 cubic yards would only bring the level of the rock down to 13¼ feet below mean low water. Mr. Townsend's bid was declined. In May, 1869, Mr. Townsend made another proposal, in which he offered to furnish all the materials, vessels, &c., &c., except the powder, electric fuse, and cartridges, for $125 per day.

This proposal was also forwarded to the Chief of Engineers, at Washington, in June, 1869, and it was there decided to accept the offer of Mr. A. W. Von Schmidt, and $25,000, and subsequently $5,000, were allotted for the work, making in all $80,000, to pay for the contract price of the work, and such other work as would be necessary under it. A contract was therefore made with him on the 16th day of June, 1869, in which he agreed to remove the rock to the depth of 24 feet of water, in accordance with the plans which he had previously submitted, for $75,000 in currency. The following is a copy of the contract:

"Articles of agreement entered into this 16th day of June, A. D. 1869, between Brevet Lieutenant Colonel R. S. Williamson, an officer in the Corps of Engineers, United States Army, for and on behalf of the United States of America, of the one part, and Allexey W. Von Schmidt, civil engineer of the city of San Francisco, State of California, of the other part.

"This agreement witnesseth, that the said Brevet Lieutenant Colonel R. S. Williamson, for and on behalf of the United States of America, and the said Allexey W. Von Schmidt, his executors and administrators, have mutually agreed, and by these presents do mutually agree to and with each other in the manner following, namely, that the said Allexey W. Von Schmidt will remove the obstruction in the bay and harbor of San Francisco commonly designated and known as Blossom Rock, to the extent and depth of 24 feet below the water surface, by measurement to be made and taken at mean low-water mark, which is the zero of the Coast Survey chart of said bay, and in the execution of the said work of removal he will adopt and follow the plan and specifications heretofore, on the 20th day of November, A. D. 1868, submitted in writing by him and accompanying his proposal to the said Brevet Lieutenant Colonel R. S. Williamson, United States Army, acting for and on behalf of the United States, for the removal of the before-mentioned obstruction, and which proposal and specifications are on file in the office of the Chief of Engineers at Washington, D. C., and to which reference is hereby made. Unless and until a practical trial of the mode and means set forth in said specifications shall prove it to be impracticable to effect the removal of said obstruction in the way and by the means proposed therein. In which case the said Allexey W. Von Schmidt shall be at full liberty to adopt and follow such other and further and different plan and means of removal as will enable him to fully execute the said undertaking to remove said obstruction. The plan to be approved by the engineer in charge of the work.

"And the said Allexey W. Von Schmidt hereby undertakes and agrees, without qualification and without reference to the success of his said proposed plan and specifications, and at all hazard, to effect and fully complete the removal of the said obstruction, to the extent hereinbefore provided, within the period of eighteen (18) months next after the execution and delivery of these presents, hereby giving and granting unto the said the United States of America, by its officers and agents thereunto duly authorized, full license and permission, at any and all times, during the progress of the work, to inspect his plans and operations in the doing of said work, and for that purpose to enter into and upon any vessels, boats, rafts, floats, and erections engaged, employed, and used in and for the same.

"In consideration of the said agreement and undertaking by and on the part of the said Allexey W. Von Schmidt so to be performed by him, and upon the full and complete performance thereof by him, his heirs, executors, and administrators, the said first-named party undertakes and agrees to pay to him, the said Allexey W. Von Schmidt, his heirs, administrators, and executors, the just and full sum of seventy-five thousand ($75,000) dollars in currency of the United States as the value of and in satisfaction for the said work.

"No member of Congress, officer, or agent of the Government, or any person employed in the public service, shall be admitted to any share herein, or any benefit which may arise herefrom.

"In witness whereof the undersigned have hereunto placed their hands and seals the day and date first above written.

"Executed in quintuplicate.

"R. S. WILLIAMSON, [SEAL.]
"*Brevet Lieutenant Colonel, U. S. A., Major of Engineers.*
"ALLEXEY W. VON SCHMIDT, [SEAL.]

"STATE OF CALIFORNIA,
"*City and County of San Francisco:*

"I do solemnly swear that the copy of contract hereto annexed is an exact copy of a contract made by me, personally, with Allexey W. Von Schmidt; that I made the same fairly, without any benefit or advantage corruptly to the said Allexey W. Von Schmidt, or any other person; and that the papers accompanying include all those relating to the said contract, as required by statute in such case made and provided.

"R. S. WILLIAMSON,
"*Brevet Lieutenant Colonel, U. S. A., Major of Engineers.*

"Sworn to before me this 17th day of June, A. D. 1869.

"F. I. THIBAULT,
"*Notary Public.*"

Attached to the contract was a bond for $10,000, with sufficient sureties.

EXCAVATING OPERATIONS UNDER THE CONTRACT.

In October, 1869, Mr. Von Schmidt commenced operations. In order to place his boiler-iron cases in position, he desired to remove a portion of the top of the rock, to have a comparatively smooth surface on which they were to rest. He therefore constructed a scow 80 feet long by 30 feet wide, and having near its middle part a well about 10 feet square. Immediately over the well was constructed a frame-work of timber about 30 feet high, from which he could work the drills to be used in cutting off and smoothing the surface for the iron cases; but the scow was found to have so much motion that he was obliged to abandon the idea of getting the iron cylinders in position by that means. He therefore commenced the construction of a crib-work of timber, which was launched and floated over to the rock in November.

The details of this crib are shown in Plate VIII. In its center is a double tank, or coffer-dam, about 10 feet square, built of plank, calked and pitched; between the outer and inner portions of the coffer-dam was a space of 2 feet, which was filled with bags of tough clay. (*b*, Fig. 2, Plate VIII.) The portion between the outer side of the dam and the outer edges of the crib was boarded up 6 feet high, forming a box around the dam. As soon as the crib was towed to its place, this box was filled with ballast, (about 200 tons of loose rock,) which caused the crib to rest on the rock. Anchors were then carried out from the crib, and the chains connecting them with its angles were drawn taut. Steel-pointed piles were next driven around its outer edges, and the rock being soft, they soon held it perfectly firm. On its top a floor was now laid, at a height of 20 feet from the rock, and on this a shed was placed, containing sleeping and cooking arrangements for about fifteen men.

The water was then pumped from the dam, and the surface of the rock within it laid bare. It was found that considerable leakage occurred from beneath. This was partially remedied, when the water was again allowed in the dam and cement and sand were thrown in, which soon hardened. On this cement bed a boiler-iron cylinder, 6 feet in diameter and 14 feet high, was placed, and between it and the wooden dam more cement was thrown in, which was allowed to harden. The water was then pumped out of the cylinder, and the leakage was found to be small.

The sinking of the shaft was then immediately commenced, (December 7.) Only one man could work in it at a time. The hoisting of the débris was at first done by mannal labor. After the excavation had been made to the depth of about 10 feet, it was found that the water came through the rock at an inconvenient rate, and a second boiler-iron tube, of a slightly less diameter, was telescoped into the first one, and cement was run in between it and the rocky surface of the shaft. This was repeated in the progress of the excavation, a third cylinder, slightly less in diameter than the second, being found necessary. The lower portion of this lowest iron cylinder was 14½ feet below the upper surface of the rock.

At the end of December, 1869, the bottom of the shaft was 22 feet below low water, and early in January, 1870, the depth was increased to 30 feet. The leakage into the shaft was now nearly checked. Drifts were then run in the direction of the longer and shorter axes of the rock. Steam was now used for hoisting, and a swinging derrick (like the one shown in Fig. 1, Plate VI) was constructed, which hoisted the tub, containing half a cubic yard of the excavated fragments, and dumped the contents on the eastern slope of the rock. Much of this débris was carried away by the tides. The work progressed so favorably during January that eight miners found space to work in the drifts, which had been run for a linear distance of 130 feet. The rock had easily been picked off, and but 10 pounds of powder (giant) were used in excavating the whole of the interior portion of it.

During February there was space enough in the various drifts to work sixteen miners. The drifts were enlarged and connected, and the interior of the excavation now had the appearance of a large chamber, having an arched roof supported by a dozen columns of rock. The average thickness of the roof of this chamber was about 14½ feet.

During March the chamber had increased in size so that its greatest height was 12 feet, greatest length 135 feet, and greatest width 55 feet. The rock columns, which previously supported its roof, were then all removed, with the exception of four near the shaft, and their places were supplied by timbers, from 8 to 10 inches square, on top of each of which a sill was placed, and between the roof and sill wooden wedges were driven. (Fig. 2, Plate VII.) Water percolated through the rock in small quantities, but a small steam-pump, placed in the chamber near the shaft, kept the floor of the excavation quite dry. With sixteen men at work in the interior of the chamber, the average day's work was about 50 cubic yards of stone.

The only tools used to loosen the stone were the ordinary steel-pointed pick, gad, and sledge. In a few instances, in the early part of the progress of the work, small blasts of giant powder were used, which did good service. During the early part of the month of April quite a heavy earthquake shock occurred, though it did not damage the rock in the least. The inner excavation was almost completed, when some of the miners, in trimming down its edges, struck gravel which had been rounded by the action of the water, and which appeared to be cemented together in a bluish clay. This circumstance frightened them, and many of them left. The crust of the rock where the gravel was struck was about 15 feet thick, through which some streamlets of water entered, though not enough to impede the work, as the pump was sufficient to check the water. This place was propped up, and excavating in that direction ceased.

PREPARATIONS FOR THE BLAST.

On the 20th of April the contractor ceased excavating. The size of the chamber was then 140 feet long, by 60 feet broad, with a maximum height of 12 feet, and preparations were at once made for putting in the powder. The position of the charges and he detailed arrangements of the torpedoes are shown on Plate IX. The kind of powder used was a nitrate of soda powder, as it was less expensive than ordinary gunpowder. A quantity amounting to 43,000 pounds was used in the various charges. The vessels for containing it were 38 ale barrels, of an average capacity of 60 gallons each, and 7 old tanks, made of boiler-iron securely riveted. The iron tanks varied in size from 5 to 7 feet in length, and from 2 to 3½ feet in diameter, and contained from 80 to 175 kegs of powder of 25 pounds each. The inside of the barrels was coated with asphaltum. It was run in while hot; the barrels were then rolled over, and afterward placed first on one head, then on the other, until the inner surfaces were covered. The outside of the casks was coated with the same preparation.

In the center of one of the heads of each cask a hole was bored, into which an iron gas-pipe tube, 1¼ inches in diameter, and about 3 feet in length, was tightly screwed, and so placed that the lower end, which was plugged up, was within 6 inches of the bottom of the barrel. That end of the tube which is outside of the barrel had another tube of the same diameter screwed on to it, which terminated with a right angle to the right and left, (the whole like the letter T,) the length being in all 5 or 6 inches. The two ends were cut with screw threads, the object of which was to receive couplings, to which air-tight India-rubber tubes were fastened. These rubber tubes were made of sufficient length to be fastened in a similar way to the barrels to the right and left, and, in fact, all the barrels and tanks were connected in that way, and finally a piece of rubber tube passed from the last torpedo, through the shaft to the crib above.

Nothing has as yet been said about the arrangement of the wires, and the charging of the barrels and tanks. Two long wires, one insulated, pass through the whole system of rubber tubes and their intermediate connections, and are eventually led up to the crib. An Able cartridge is now placed about the middle of the gas-pipe tube, which is in each barrel, and from the cartridge lead two wires, each about 22 inches long, one of which is fastened to the long insulated wire, and the other to the other long wire, as shown in Fig. 3 of Plate IX.

That portion of the gas-pipe tube which was within the barrel was perforated with holes one-eighth of an inch in diameter, and about 4 inches apart. This tube was filled with rifle powder. The barrels were filled through the bung with the nitrate of soda powder. By this arrangement it was supposed that when a cartridge was ignited, the quickly acting rifle powder would ignite the more slowly acting soda powder in many places, thus insuring the burning of all of it. When filled, the barrels were securely plugged, and an iron hoop was driven around each of them over the bung to prevent it from being driven into the cask from the pressure of the water tamping when the chamber and shaft were filled with water.

The wooden cask torpedoes were placed against the edges of the excavation, and about 8 feet apart. The iron tank torpedoes were distributed in the interior near the rock columns. When all were in position it appeared as though each torpedo was connected with the adjoining ones by an India-rubber hose. Each torpedo was braced and fastened in position by means of timber, so that when the chamber became filled with water, they would not float about.

It was feared that when the water was introduced into the chamber its pressure would crush some of the barrels, unless some counteracting force prevented. An air-pump was, therefore, brought into requisition. In order to see that there was no leakage, air was forced through the hose to the various packages of powder. The test was satisfactory.

All the arrangements having been completed, it was publicly announced that at noon of April 23 the explosion would take place, and immense crowds collected on Telegraph Hill, and other prominent places in the city, to witness the novel sight. On the morning of that day a hole, about 5 inches in diameter, was cut in the iron case about 2 feet above low-water mark. As the tide rose the water flowed through the hole, and at noon of that day the chamber was two-thirds full of water. The indicator of the air-pump at that time indicated a pressure of 5 pounds to the square inch. At 2 p. m., everything being ready, an insulated wire was connected with the one brought up though the hose, (the end of the other wire being in the water,) and a boat containing the Beardslee's magneto-electric battery and the coil of insulated wire pushed off from the crib, paying out the wire as we proceeded. When about 800 feet from the crib the wire was cut, and the end connected with one of the poles of the battery, the circuit being completed by a wire connected with the other pole, dragging in the water. One turn of the battery crank and the explosion instantly followed. A column of water, variously estimated at from 200 to 300 feet high, rose majestically in the air. The diameter of the body of water thus thrown up was probably 200 feet. Around the base of this column was another simultaneous outburst of water, probably 70 feet high, whose flood seemed to roll outward. High above the mass of water could be seen rocks and pieces of timber. The highest jet of water was that which came through the shaft, and appeared as black as ink.

An examination, made shortly after the blast, showed that the shoalest part of the water over the rock was but 14 feet deep at mean low tide. As this shoal place was but of small area it was thought to be the old dump-pile, as a pole could be thrust for several feet into the mass of broken rock of which it was composed. It was also thought that the tides would carry off a considerable portion of this broken mass; but after waiting several days and again examining the locality, it was found to be in nearly the same condition as immediately after the blast. It was therefore necessary that the contractor should take some active steps toward removing the débris. For that purpose he constructed a rake, (see Plate X.) It was made of heavy wrought iron, weighing 2½ tons, and its general appearance was that of an ordinary garden rake, except that all its parts were very much heavier. It was 8 feet wide. Each tooth was about 28 inches long, and slightly curved, with a width of 3 inches and an average thickness of about 5 inches. The space between two teeth was 2 inches. Its handle was of heavy iron, and about 8 feet in length. When ready for use it was lowered through the well, which was in the middle of the scow, by means of three ropes, two of which passed over a windlass at the rear part of the well, and were fastened to the two sides of the rake, while the third rope, coming from a point on the front part of the top of the well, was attached to the handle of the rake. While in position the handle of the rake was horizontal and its teeth nearly vertical. To prevent its sagging to the rear when the scow was moved forward, a chain was attached to each side of it, and the two led forward to the bow of the scow, where they were fastened.

When a steam-tug attached to the scow was moved back and forth over the rock the rake generally scraped the débris into deep water, and the depth of water over the rock was increased a few feet. Occasionally pieces of timber would float to the surface, and as they all proved to have been part of the crib-work, packages of powder were placed on the surface of the rock and exploded, with the hope of breaking up the remainder of the crib. The result was, that numerous other pieces, varying from a few inches to 12 feet in length, were disengaged from the mass of the débris, and came up to the surface. This led to the conclusion that at the time of the explosion the lower part of the crib-work, which consisted of a box filled with 200 tons of rock, must have broken in two, and fallen down bodily into the crater which the blast had produced. In raking over the rock, the small loose pieces of stone would be dragged along until the rake came in contact with the interlaced timbers of the crib-work. This would temporarily check the progress of the tug, and it was supposed that it caused the rake to jump over the obstacle, and form a new dump. A diver was several times sent down on the rock. He stated that it was broken to pieces, the largest of which would not measure more than half a cubic yard, and that their average size was about that of a hen's egg. He moreover reported that at his last descent he could find no timber. Charges of powder, varying from 25 to 75 pounds, were occasionally lowered to the spot and exploded, with results similar to those of previous blasts. At last, on the 25th of May, the contractor informed us that he thought he had obtained the requisite depth of water.

An experiment was made a few days afterward, by passing the rake over the surface of the rock, noting the depth of water at the time, and then ascertaining the height of the tide at the time of the experiment from the self-registering tide-gauge at Fort Point. It was found that the surface of the rock was uneven, and that many of the lumps did not have 24 feet of water over them at mean low tide. The contractor therefore resumed work as before.

It was found very inconvenient to go to Fort Point, about four miles distant, to examine the readings of the tide-gauge there, and consequently the contractor placed a floating gauge at Cozzens's Wharf in the city, a place directly opposite the rock. The zero of this gauge was determined from the observations taken during a few days, and this zero at that time was supposed to be mean low tide. From time to time during a few months after the blast the contractor requested that an experiment be made, which was done, resulting in determining that the necessary depth of water had not been obtained. In the mean time the method of testing the depth of water by means of the rake was not satisfactory to all the parties interested, and Lieutenant Heuer devised what he called a boom. (See Plate X.)

Two pieces of timber, each abont 25 feet long and 12 inches square, were nailed to two cross-pieces of timber in such way that the space between the two long pieces was about 2 feet. These cross-pieces were secured at points abont 5 feet from the end of the logs, and the whole constituted the floating or buoyant part of the apparatus. On the cross-pieces, and midway between the logs, holes were bored corresponding with those in the two cast-iron cylinders, standing on flat rectangular bases, which were screwed to the cross-pieces. The cylinders were 7 inches high with an interior diameter of $2\frac{1}{16}$ inches, the thickness of the iron being $\frac{1}{2}$ inch. Through the cylinders and the holes through the cross-pieces, gas-pipes, 2 inches in diameter and 30 feet long, passed. The gas-pipes hung vertically, and could be fastened at any desired depth by set screws attached to the cylinders. The lower end of each pipe terminated in a T, through which a bar of iron, 30 feet long by 2 inches in diameter, passed and was fastened. The gas-pipes were graduated, and when both were lowered the same distance, the iron bar was horizontal. Experiments were made with this apparatus, referring the soundings to the contractor's gauge.

As the rock was gradually removed and the required 24 feet of water at mean low tide was nearly attained, it became a question whether the contractor's gauge, the zero of which had been determined from observations taken during a few days only, was correct or not; and also whether the water-level at low tide at the gauges at Fort Point Wharf and Cozzens's Wharf, four miles apart, were practically on the same horizontal plane. Lieutenant Heuer, therefore, ran a line of levels between the two points, thereby, in fact, carrying the mean low-tide mark at Fort Point to Cozzens's Wharf. The contractor run a similar line of levels to test the accuracy of Lieutenant Heuer's work, and the results by the two differed by less than an inch. With these data, a United States gauge was established at Cozzens's Wharf, the zero of which corresponded, as nearly as possible, with the zero of the gauge at Fort Point. On comparing the two gauges at Cozzens's Wharf, it was found they differed over a foot, the United States gauge giving the highest reading. The latter gauge was not a floating one, but was merely a graduated rod fastened to a pile, and it was difficult to read it with accuracy in ordinary conditions of the bay, and almost impossible to do so when the bay was rough; still it was impossible to conceal the fact that this discrepancy existed between the two gauges, and although the experiment made on the 20th of August showed that there was 24 feet of water over the rock at mean low tide by the contractor's gauge, it was necessary to inform him that he had not yet fulfilled his contract.

Other official duties required us to visit Oregon. We sailed on the 2d of September and returned on the 14th of October, and during this interval tidal observations were taken at all low tides by an observer employed by the United States. On our return it was ascertained that the work had been suspended by the contractor, who insisted that he had complied with the terms of his contract. A careful examination was made of the observations taken in the interval, which were compared with corresponding ones at Fort Point, and the result was a full confirmation of the fact that the contractor was mistaken. Upon being convinced of this, he acknowledged his mistake, and resumed the work of removing the rock.

The discussion of the subject was quite interesting, bringing out several points of importance not thought of in the beginning of the work, and therefore it is thought best to insert here the following extract of the official letters written to the contractor, and on the strength of which he resumed work on the rock:

"SAN FRANCISCO, *October* 20, 1870.

"SIR: * * * The first matter of investigation was the error in the position of the tin pointer of your gauge, which you supposed to read zero when at mean low water, (defined by the Coast Survey to be the level of average lowest low water.) From the discussion of the observations taken with your gauge at Cozzens's Wharf, from September 5 to October 14, inclusive, I find the mean low-water line to be —0.357; that is, the tin pointer must be moved down 0.357 of a foot in order to correspond with the mean low-water line deduced from the above-mentioned observations. A mean of the 25 observations from September 5 to September 30, inclusive, gives the number —0.377 instead of —0.357.

"The mean low-water level deduced from this short series of observations is different from that deduced from a series of many years' duration. I therefore have compared the observations taken at the Fort Point gauge with the mean low-water line of the Coast Survey, determined from a mean of fourteen years' observation, and I find that during the twenty-five days commencing on the 5th of September, (the Coast Survey observations for October cannot be obtained until the end of the month,) the mean of the lowest low water was + 0.694; that is, the average height of the lowest low waters during that period was 0.694 feet above the Coast Survey mean low-water line. Therefore the difference between your tin pointer and the mean low-water line of the Coast Survey is 0.694—(—0.377)=1.071.

"In the following table will be found a copy of the low-tide observations taken in September at Fort Point, and at your gauge on Cozzens's Wharf:

FORT POINT.			COZZENS'S WHARF.		
Height of low tides above mean low water.			Height of tides by Von Schmidt's gauge.		
Date.	Tide.	Time.	Date.	Tide.	Time.
September 5	0.29	2.10 a.m.	September 5	—0.78	2.25 a.m.
6	0.19	2.52 a.m.	6	—0.89	3.20 a.m.
7	0.13	3.14 a.m.	7	—0.93	4.10 a.m.
8	0.04	4.20 a.m.	8	—1.00	5.00 a.m.
9	0.11	4.18 a.m.	9	—0.95	5.25 a.m.
10	0.59	5.30 a.m.	10	—0.48	5.50 a.m.
11	0.79	6.00 a.m.	11	—0.26	6.30 a.m.
12	1.04	6.37 a.m.	12	—0.00	7.10 a.m.
13	1.69	7.03 a.m.	13	+0.57	7.20 a.m.
14	1.71	8.37 p.m.	14	+0.65	8.30 p.m.
15	1.64	9.33 p.m.	15	+0.54	10.05 p.m.
16	1.49	10.40 p.m.	16	+0.39	10.55 p.m.
17	1.17	11.47 p.m.	17	+0.09	11.50 p.m.
18	....	....	18	....	....
19	0.87	12.48 a.m.	19	—0.22	12.55 a.m.
20	0.67	1.37 a.m.	20	—0.46	1.55 a.m.
21	0.49	2.30 a.m.	21	—0.62	2.50 a.m.
22	0.42	3.03 a.m.	22	—0.65	3.20 a.m.
23	0.29	3.50 a.m.	23	—0.72	4.15 a.m.
24	0.34	4.20 a.m.	24	—0.80	5.00 a.m.
25	0.51	5.00 a.m.	25	—0.55	5.10 a.m.
26	0.69	6.15 p.m.	26	—0.33	6.45 p.m.
27	0.53	7.07 p.m.	27	—0.52	7.25 p.m.
28	0.59	8.05 p.m.	28	—0.45	8.35 p.m.
29	0.69	9.14 p.m.	29	—0.35	9.20 p.m.
30	0.39	10.17 p.m.	30	—0.70	10.43 p.m.

25)17.36 +.6944=Average above mean low-water.	25)—9.42 —.377=Average value of mean low water at Cozzens's Wharf below the contractor's zero.

"The number 1.071 represents the distance your tin pointer must be moved down in order that your gauge reading corresponds to that of the Coast Survey at mean low tide at Fort Point. The scale reading of the United States gauge at Cozzens's Wharf and the Fort Point gauge would be the same if the water between the two places at low tide were on the same horizontal plane, and they would be at mean low water 3.411, that being the reading of the Fort Point scale at mean low water. The mean of the low tide readings at Fort Point from September 5th to September 30th, inclusive, is 3.411 + 0.694=4.105. The corresponding reading of the United States gauge is 4.435. The difference is 0.330. If the lower ends of the two gauges are on the same horizontal plane, as is believed to be the case, and if the observations were correctly taken, then this difference can only be accounted for by a slope of the waters between the two places. I must state, however, that the observations at the United States gauge were quite difficult in rough weather, and could not be relied upon within a tenth of a foot.

"Supposing that this 0.33 of a foot in your favor were allowed by the Chief of Engineers, you have still to remove 0.741 of a foot before the required 24 feet of water over the rock is obtained. The number 0.741=1.071—0.330.

"I state for your information that I have learned officially from the Coast Survey Office in Washington that the mean rise and fall of the tide at Fort Point is 3.76 feet, and at Meiggs's Wharf, near Cozzens's Wharf, it is 3.86 feet.

"A copy of this letter will be forwarded to the Chief of Engineers.

Very respectfully,

"R. S. WILLIAMSON,
"*Major United States Engineers.*

"Mr. A. W. VON SCHMIDT, C.E.,
"*Contractor for Removing Blossom Rock.*"

It is difficult to conceive that in an open bay like that of San Francisco there should be a perceptible difference of level between Cozzens's Wharf and the wharf at Fort Point; but being confident that the lines of level run by the contractor, and Lieutenant Heuer on the part of the United States, gave essentially the same results, and being unable to conceive of any other cause for the difference of 0.33 of a foot, except an actual difference of level of the waters at low tide between the two points, this 0.33 of a foot has been given in favor of the contractor, as, in fact, have all doubtful points been given to him.

Being convinced of the truth of the facts contained in the above letter, the contractor resumed his work with the view of removing three-fourths of a foot of the rock at such parts of it as the removal was necessary. On December 6, 1870, I received from him the following letter:

"SAN FRANCISCO, *December* 6, 1870.

"SIR: I have the honor to state that I have removed from the surface of Blossom Rock, since your last survey, 700 cubic yards of stone.

"So far as I am able to ascertain, I have 24 feet of water over the rock at mean low water.

"I most respectfully ask you to order a survey to be made for your own information, and hope that you will be pleased to accept the work.

"I would propose that at 10 o'clock to-morrow would be a good time for the survey, on account of the tide.

"Very respectfully,

"A. W. VON SCHMIDT,
"*Civil Engineer, &c., Contractor for Removing Blossom Rock.*

"Major R. S. WILLIAMSON,
"*United States Engineer.*"

In consequence of this letter we were at the wharf at the time appointed, where we found the tug, the scow, and the boom ready for us. The boom was set to the proper depth of water; on it stood Lieutenant Heuer with a lead line in hand, and the apparatus was very slowly and frequently towed over the rock, until every portion of it must have been passed over by the boom. The boom did not strike the rock, and every sounding indicated 24 or more feet of water over it at mean low tide. On the following day the work was accepted, and the contract money paid to the contractor.

The officer of the Coast Survey in charge on this coast, Assistant George Davidson, had intimated that, as soon as our operations were over he would make a survey and chart of the portion of the bay where the rock formerly stood. The survey was made, but before the chart was finished the subordinate officer of the Coast Survey who made the hydrographic survey became sick, and the work was delayed until he should recover. An examination of the soundings taken by the United States Coast Survey showed that there were four lumps on the rock which had not quite 24 feet of water over them. I therefore directed Lieutenant Heuer to make the survey of the rock.

METHOD OF MAKING THE FINAL SURVEY OF BLOSSOM ROCK.

A scow, 46 feet by 28 feet, was moored on the rock by means of four anchors and lines. Two observers on shore, and distant about one mile from the scow and from each other, took angles simultaneously with theodolites, on a flag staff erected on the scow. The direction of its axis at the same instant was determined by compass on board. As soon as the theodolite men had observed its position, two men with lead lines (one on each side and end) would sound all around it. When these sets of soundings were completed, its position would be slightly changed, the theodolite men would again be signaled, would observe its new position, and soundings would be made as before. This operation was repeated many times, until the whole surface of the rock was covered with soundings. We obtained over 1,800 soundings, about 1,300 of which were plotted.

After the soundings were reduced to mean low-water level and plotted, it was found that there were seven places where there was less than 24 feet of water. At these places there appeared to be small masses of loose rock, about the size of a cubic foot or less, rising above its general level. They were so small that it was often difficult to find them a second time. In previous examinations which had been made by us by means of the sounding float or "boom" we had found no place where there was too little water, and therefore the money had been paid to the contractor. As soon as the detailed survey above described was completed, the contractor was informed that these seven lumps still existed on the rock; he therefore, at his own expense, and with as little delay as possible, sent down a diver in armor, who found the lumps. He reported that the surface of the rock was uneven, like furrows, and was covered with stones, usually quite small, and seldom as large as a cubic foot. All the lumps on these ridges were scraped off into deeper water. He went down twice, remaining nearly an hour each time. He could only go down about slack water.

We made a resurvey of that portion of the rock which had contained the lumps, and found over each of them 24 feet or more of water. Some of these lumps may have existed when that survey was made which resulted in the money being paid to the contractor, because they were so small, and being detached masses were not detected. Some of them, however, were made during the recent survey, when, several times, rocks, used as sinkers to buoys, had been lowered on the rock, and left there by the parting of the lines to which the buoys had been attached. The survey could only be made when the bay was smooth, and only fourteen days suitable for the purpose were found during three months. The soundings over the rock at the final survey are shown on Plate XI.

CONCLUDING REMARKS.

In concluding this report a few words with regard to the manner of conducting the work, the defects in it, &c., may be of value, though they are the natural deductions from the operations already detailed. The main defect was in firing the charges of powder before a sufficient amount of excavation had been made. A glance at the original plan, as partly shown on Plate VI, (the stone pillars were to be replaced by wooden ones,) and the plan actually followed out as shown on Plate VII, shows at once that in the former case the amount of excavated rock was so great that when the shell of the rock was broken and lifted up by the force of the explosion, the greater portion of the débris would fall into the excavation, and there would be at least the required 24 feet of water over the rock or débris; and in the latter case, the amount excavated was not half as much as the amount of rock remaining above the line of 24 feet at mean low water. Consequently, just after the blast there was only 14 feet of water over the débris. In order that the mass of rock over the 24 feet line should equal the mass excavated, about ten feet more of excavation should have been made.

The contractor and many others supposed that the tide would sweep away the loose débris, but this idea proved fallacious.

It was supposed that a crust of only 6 feet thick, supported by the pillars of rock or wood, would be admissible; but, in fact, a thickness of from 14 to 18 feet was required to prevent the water from entering the chamber in quantities greater than could be easily controlled; but there was no practical difficulty in excavating more in the central part of the rock, though toward the edges suspicious leaks had developed themselves. The removal of the débris probably cost more than the amount expended up to and including the time of the blast. Had he made this 10 feet of additional excavation, it is probable he would have been perfectly successful. Again, the chamber containing the powder being only about two-thirds full of water at the time of the blast, made the resistance very much less than it would have been had the chamber as well as the shaft been filled, so that the water would have stood on the same level in the shaft as on the outside. To that fact may be attributed some of the contractor's want of perfect success.

Mr. Von Schmidt deserves a great deal of credit for the work he has achieved. His daring character is shown by his accepting a contract in which he was to receive no money until the completion of an experiment the success of which could only be decided by the United States as the sole arbiter. The energy with which he pushed forward the work until the explosion took place, and the renewed energy with which he pursued his labor under such discouraging circumstances, deserves the success he attained.

W 10.

Report on and plan for the impvovement of Wilmington Harbor, California, made under the instructions of the Chief of Engineers, dated the 22*d day of March*, 1871.

SAN FRANCISCO, CALIFORNIA, *June* 15, 1871.

Congress, at the last session, made an appropriation of $200,000 for a breakwater at Wilmington, California. Wilmington is situated at the head of a small estuary which has its outlet in the bay of San Pedro.

This bay affords good anchorage and shelter for vessels during the greater part of the year. It is well covered from the northerly winds which prevail during the summer months, but it is open to the southerly gales which occur frequently in the winter. At such a time a vessel at anchor in this bay is compelled to run for shelter under the lee of one of the large islands which lie a few miles off the coast. As for a harbor, there is none nearer than San Diego, ninety miles to the southward, and to the north none nearer than San Francisco. This bay is the outlet for the productive plains about Los Angeles, and for a large extent of country to the eastward, which sustain a fleet of steamers and sail vessels of considerable size. Under this condition of things, it is apparent that a breakwater in the bay of San Pedro, which should give security to vessels under its lee at all times, would be a very desirable construction, and it is probable that at some future day the commerce of this bay may attain such dimensions as to justify its construction, which could not be made under an expense of several millions of dollars.

This construction is not, however, the one contemplated by the act of Congress.

This act looks to the improvement of the harbor or estuary of Wilmington.

The copy of the Coast Survey chart, herewith inclosed, exhibits an estuary about three miles in length, its navigable portion ending at Newtown or Wilmington, and its lower part expanding in a shallow bay divided from the bay of San Pedro by a bar with a depth of water less than 3 feet at low water.

Although the estuary in its navigable part is small, in no part exceeding seven or eight hundred feet in width, it is encompassed on almost all sides by extensive flats, which are covered by water at high tide. These flats extend for more than a mile above Wilmington, and below the village lie on either side of the stream. The area of the part of the estuary and flats lying above the lower end of Rattlesnake Island is about 1,300 acres. If we suppose this tidal area to be covered to an average depth of four feet, which is not far from the depth due to a spring tide, the quantity of water which ebbs and flows in one tide is more than 257,000,000 cubic feet.

The tidal ebb is not re-enforced by fresh water. No streams discharge into this estuary. The bed of San Gabriel river lies close along the upper edge of the estuary, and at nearly the level of the estuary, so that this river is liable to empty its flood-waters into this inlet, but the river bed is dry for the greater part of the year; and it is only for a short period in the winter that any water can be expected from this source, and this is not to be expected except in case of high floods in the river.

Within a few years this river has opened a new channel and outlet into the ocean, 10 miles to the southward. It is not probable that any considerable amount of discharge into the estuary will occur. Moreover, it is scarcely desirable, for the river waters bring with them a mass of sand and detritus, which are deposited on the flats and channel, shoaling the water and reducing the tidal area.

Referring again to the Coast Survey chart, we observe that the upper part of the channel is separated and protected from the ocean by Rattlesnake Island, which is a narrow strip of grassy sand dunes rising 8 to 10 feet above high water. Following along the seaward line of the channel, toward Deadman's Island, we cross a line of low flats, bare at low water, and rising above low water to a variable height of 2 or 3 feet. These flats extend for about two-thirds of a mile, and serve to do, in a partial degree, what is better done above by the higher bulwark of Rattlesnake Island, namely, to cover the channel from the sea, and to confine the ebb current between banks.

We observe that a navigable depth is preserved in the channel so long as these flats exist, and that when we leave them behind we enter upon a wide shallow bay with no particular channel in any part.

Now, if we conceive Rattlesnake Island, or even the flats just spoken of, to be extended to Deadman's Island, and the channel to be thus confined, so that the ebb-tide shall be compelled to find its exit between Deadman's Island and the shore, instead of escaping as it now does, all the way from Rattlesnake Island to Deadman's Island, and thence to the main land, there seems no reason to doubt that the ebb current would, in time, excavate for itself a much deeper channel than now exists in the lower part of the estuary, provided, of course, that the bottom is of a yielding character. The first half of the ebb now escapes all along the line just referred to, but our observations indicate scarcely any velocity through the two small channels just below Rattlesnake Island, after half ebb. Before this period, however, the ebb escapes here, to a great extent, as well as over the flats.

The object to be attained is to connect Rattlesnake and Deadman's Islands. The survey made for the purposes of this report indicates considerable changes in these flats since the date of the Coast Survey map, which was made in 1859. The flats have been extended toward Deadman's Island, and in some parts have become higher, rising in one place for a small distance above high water.

It is proper to remark here that these flats are composed of fine sand, hard and compact in appearance, but, like most of the coast sands, at times and places quicksands. It has been found that an object of weight placed on the sands sinks, and soon becomes imbedded. Our observations show the existence of a clay-bed in many places below these sands.

Any artificial structure placed between Deadman's Island and the flats near Rattlesnake Island must be made strong enough to resist the action of the sea, particularly on the part nearest to Deadman's Island, where the 12-foot curve comes in close to the island. The degree of exposure will diminish as we approach Rattlesnake Island, as we learn from the soundings in the chart. The shoalest water on the upper part of this line is from one-third to one-half a mile outside of the positions we propose to occupy, so that the waves can never reach our construction in their integrity.

Colonel Williamson, in his report published in that of the Chief of Engineers for 1869, estimated for a riprap of stone, on substantially the same line which it is now proposed to occupy, at a cost of $892,000 in coin. There is no reason now to suppose that adequate protection and improvements could be afforded at a less cost by the use of this material, and this great expense leads to the inquiry whether wood cannot be used, at least in part, to advantage.

For a great part of the line cribs of wood would be more expensive, and, I think, a less secure construction than sheet-piling. The shifting sands are so easily moved, either by the powerful agency of storms or the more quiet and constant action of the currents, that cribs, unless founded on the underlying rock or clay, would be subject to the danger of being undermined; while at the same time they would not give the best kind of resistance to a change of direction in the channel. For instance, it is a supposable case that the outlet should have a tendency to make out through one of the channels opening to the eastward just below Rattlesnake Island, and in this event the crib-bulwark might be undermined and overthrown, and the current would have its course more or less free direct to the ocean; but if we sheet-pile this part, the current is obliged to eat its way to the foot of the piles before its course is open.

On the accompanying drawing entitled "Proposed construction for the Wilmington breakwater," will be found plans and sections of structures, five in number, with which it is proposed to occupy the line between Rattlesnake Island and Deadman's Island.

Construction No. 1 is the simplest and cheapest, and with this it is proposed to cover the portion of the line from Rattlesnake Island to the end of the flats, from X to Y, 3,630 feet; with this reservation, that in crossing the channels near the island, for a distance of 550 feet, construction No. 5 shall be used.

From Y to Z, Z being about 500 feet from Deadman's Island, it is proposed to build construction No. 3, which consists of two rows of heavy piles, driven in each row close together, the rows 10 feet apart, well braced and filled with stones. The sheet-piles in every case to reach below the probable depth of the adjacent channel.

From Z to Deadman's Island, a distance of 500 feet, where the bottom is rock in place, it is proposed to use cribs filled with stone, as shown in construction No. 4.

Now it is possible, as we build toward Deadman's Island, that the increased velocity of the current may wash out the line ahead, so that it would not be safe to use construction No. 3, so far as is now proposed, and in this case it may be necessary to use cribs over a larger portion than now anticipated.

Stone is not found about the bay of San Pedro in any great quantity, and what there is has no good qualities. Stone filling of cribs will, for this reason, be expensive. This circumstance accounts for construction No. 2, which it may be practicable to use on the less exposed portion of the line. This construction resembles No. 3, but differs in some details of the timber-work, and in the filling, which is of sand instead of stone.

The line to be occupied is indicated on the tracings of the harbor in a heavy black line, so located as to afford easy flow to the current and to leave sufficient width for the probable channel.

The largest section of the estuary now is opposite the lower end of Rattlesnake Island, where the depth is as much as 20 feet. The area of this cross-section is nearly 7,900 square feet at low tide. All the tidal water to fill the flats above, ebbs and flows through this section. It is questionable, perhaps, whether so much water will ebb and flow in the estuary after our case construction is completed, as is now the case; but opportunity is left for the excavation of a cross-section at least equal to that above named.

It will be observed that these constructions are not carried far above high water.

It is to be presumed that the flats where construction No. 1 is to be placed, will, by virtue of the construction, be elevated to the top of the timber-work. It is supposed that the obstruction will intercept and hold the sand, and that after a time, longer or shorter, a strip of sand dunes, similar to those on Rattlesnake Island, will spring up on these flats, imbedding the timber-work, which when imbedded will have done its work; and henceforth it remains a matter of indifference, comparative at least, whether the bulwark remains sound or decays. Here, as on the other part of the line, the object of the work is less to cover the interior waters from the wind and waves, than to give proper direction to the ebb current.

Timber used in these circumstances is not only subject to usual causes of decay, but that portion exposed to constant immersion in the water is liable to the attacks of the teredo navalis, or ship-worm.

The first part of the air-line from X to Y, with the exception of the water-way of the little channels, may, I think, be constructed of unprepared timber.

The only process for treating timber by hydro-carbon oils, used on this coast, is the vapor, or Robbins process. The Seely process is not used here.

So far as I can learn, there is some reason to suppose that the Robbins process is likely to afford some protection against the teredo navalis. Experiments have been made in this harbor, extending over two years, which give promise of beneficial results, but the only real test, which is time, is wanting.

There is evidence, apparently conclusive, that the Bethell process, when applied to the extent of 10 pounds of oil to the cubic foot, afforded security; but to effect this requires expensive machinery, and involves a pressure of 150 to 200 pounds per square inch. The wood was saturated with oil. Neither the Seely nor the Robbins process pretend to accomplish so much, and if I am correctly informed as to the probable cost of effecting this result, it would be out of the question to think of doing it. The Robbins company, however, claim to saturate the wood to the depth of an inch, and to expel the albuminous matter from the whole of the timber.

Now it costs $10 per thousand feet, board measure, to treat timber here by the Robbins process—price in gold. I have received an offer from this company to establish works at Wilmington for the purpose of treating this timber, for $15 per thousand in gold.

This seems to be the state of the case: either the vapor process at $10 per thousand here, or no treatment. It is quite certain that in three or four years, if we do not treat this timber, the worms will have destroyed it. It is not certain, but it is probable, if we do treat it by this process, that it will last longer, how much longer cannot be said.

It is certain that the reputation of the company will be at stake in this case, if their treatment fails and the worms destroy the timber in the usual time, or they can never expect to treat any more timber for such purposes after the fact becomes known. I think, then, that they will try to make good work, and I am of the opinion that the experiment ought to be made.

It is proposed to collect the materials, so far as the available money will permit, during the coming fall and winter, and to this end advertisement ought to be made at once for lumber. I inclose with this report a copy of an advertisement for bids for lumber:

X to Y.	The cost of 3,080 feet construction 1, at $20 per foot, is	$61,600
	The cost of 550 feet construction 5, at $35 per foot, is	19,250

Allowing for contingent expenses, there will remain about $100,000 available for purchase of lumber for the part between Y and Deadman's Island.

Lumber can be treated here and freighted to San Pedro, and piled on Rattlesnake Island, for $40 per thousand. Hence, we have left after building the line XY, money enough to buy 2,500,000 feet of lumber. This ought to be bought and treated, and piled on Rattlesnake Island.

The time to begin the construction is in the spring, say by March 1, 1872. The storms of winter might interfere greatly, and perhaps do serious damage to work in course of construction. Several months ahead, then, it is proposed to advertise for the construction of the line XY, the contractor to take the lumber from Rattlesnake Island, he to furnish all the material except the lumber.

If adequate appropriation should be made by Congress in time, say not later than February, 1872, new contracts should be made for the construction of the line Y to Deadman's Island, so that the whole work should be completed in the autumn of 1872. If, however, the appropriation should be delayed until July or August, it would be too late to do the work during the summer of 1872. In other words, the portion from Y to Deadman's Island ought not to be commenced until there is money and time enough to finish it in one season.

As has been remarked, there is no harbor on the coast between San Francisco and San Diego. There are several ports with landings more or less secure, but they are all exposed to the southerly winds. The anchorage of San Pedro is the most important of these roadsteads. This port is the outlet of the country about and to the eastward of Los Angeles. I inclose a statement of the commerce of the port during the past year, from which it appears that 147 steamships and 56 sail-vessels brought and carried away freight to the amount of 17,550 tons weight, and nearly 6,000,000 feet of lumber, besides a large quantity of articles not included.

Now all this freight is delivered to, or received from, the vessels by means of lighters, the vessels anchored outside near Deadman's Island.

These lighters are towed to Wilmington from the ship, or to the ship from Wilmington, and each package undergoes an extra handling. The business of towing employs two steamers, about a dozen lighters, with a considerable force of men. All the expenses thus incurred are a tax upon the trade of the port. Now, if this harbor can be made to admit the smaller class of sea-going vessels, the freights will be discharged on the wharf, from which it will be taken by the railroad to the interior.

It is quite to be expected that under such favorable conditions the trade of the port will be greatly increased.

Indeed, this saving of lighterage may make all the difference between prosperity and poverty for the agricultural district which here finds its outlet. It constitutes in itself a fair profit upon some kinds of agricultural production.

The chief exports from Wilmington consist of oranges, lemons, wines, wool, corn, brandy, beans, and dried fruit. A considerable quantity of lead and silver bullion from the interior is exported.

At Wilmington is the terminus of the San Pedro and Los Angeles

Railroad, which connects the coast with Los Angeles. The latter is a city of six or eight thousand inhabitants, surrounded by a fruitful and growing country.

The trade of the past year, it should be remembered, is that of a very dry season. The occurrence of droughts every few years is indeed the greatest drawback to this section of the country. San Pedro is a port of delivery.

Among the drawings herewith inclosed is a section of the water-way between Deadman's Island and the shore, from which it appears that a rocky reef makes out from both sides, and which is lost in the middle of the channel. Supposititious lines of its outline where not found are given on the section. It is not as yet clearly defined in position and extent, and it will be necessary to make some further observations on this point.

It is probable that these observations may develop a necessity to make the entrance to the harbor on the other side of Deadman's Island; but however that may be, the part of the line which it is proposed to build with the present appropriation, viz, XY on the plan, is common to either project.

The entrance to the west of Deadman's Island is better than the other, for the reason that the latter would open to the eastward, directly in face of the heavy swells which roll up in the winter storms, which would have a tendency to fill up the mouth of the harbor. This particular point will be the subject of a future report.

The observations and survey upon which this report is based were made by Mr. White, civil engineer. They were intended to exhibit the direction of the changes which have taken place since the survey of 1859, to determine the character of the underlying strata, to ascertain the tidal conditions of the harbor, and to determine the practicability of the constructions proposed. He discovers that on the upper portion of the line the substrata are of sand to the depth of at least 15 feet, and that piles may be driven without unusual difficulty. On the lower part of the line near Deadman's Island we find a soft and, at times, hard clay a few feet, generally less than 6, below the surface of the bottom. The same kind of formation extends at least in part (for on this point our observations are not extended) across what is now the shallowest section, from Deadman's Island to the goose-necked spit that makes out from the main shore.

The overlying sand in the channel will be easily moved by the ebbing current. Whether the underlying clay will be worn to the desirable depth by the action of the current can only be satisfactorily known after trial. Our observations indicate with certainty a depth at mean low water of 7 feet at the mouth of the harbor; it is very desirable to have 10 feet. It is possible that this can only be attained by dredging. No estimates for deepening by dredging are included. It will be time enough to estimate for this when the necessity for it becomes apparent.

The safety and preservation of this harbor lie in the preservation of its tidal area, which is mainly made up of the extensive flats heretofore referred to. It is indispensable that they should not be occupied so as to diminish the quantity of water to ebb and flow.

Drawings accompanying this report:

1. Coast Survey map of Wilmington Harbor, with certain changes marked thereon.
2. Profile of line proposed from Rattlesnake for Deadman's Island.
3. Profile section of reef between Deadman's Island and the main.
4. Sheet of plans and sections proposed for different constructions.

Papers accompanying this report:

A. Exhibit of the commerce of Wilmington for the year 1870.

B. Sheet of estimates.

C. Proposed advertisement for lumber.

In view of the possible contingencies in a construction of this kind, and of the disastrous results that might ensue from even a very small deficiency in money, at the last moment, I think good policy requires appropriation beyond the estimates.

For these reasons I venture to recommend an additional appropriation of $200,000.

Respectfully submitted.

G. H. MENDELL,
Major of Engineers.

P. S.—Advertisement not inclosed; it will be forwarded in a few days.
G. H. M.

Drawings in a roll mailed the 16th of June, 1871.

A.

LOS ANGELES AND SAN PEDRO RAILROAD COMPANY.

Exports during A. D. 1870.

1, 631	tons assorted merchandise.	
1, 796	pipes and puncheons wine and brandy,	282,022 gallons.
550	barrels wine and brandy,	
177	half barrels,	
6, 986	bales wool, 2,457,427 pounds.	
34, 971	sacks corn, barley, and rye, 3,827,606 pounds	
4, 356	sacks corn-meal and rye flour.	
15, 021	boxes oranges, lemons, &c.	
322	bales sheep-skins.	
3, 133	dry hides.	
2, 450	salt.	
21, 704	bars bullion, 1,989,100 pounds.	
3, 825	sacks beans, 304,250 pounds.	
322	barrels and sacks walnuts.	
24	sacks hemp and flaxseed.	
528	cases honey.	
38	cases beeswax.	
86	cases eggs.	
266	barrels broom-corn, 106,212 pounds.	
266	sacks peanuts.	
1, 221	bales hay.	
168	bags ore.	
8	buggies and wagons.	
80	bales hops.	
197	bales dry fish.	
72	barrels oil,	3,720 gallons.
4	pipes oil,	
10	cords wood.	
14	head of horses and cattle.	
167	sacks dry fruit, 85,761 pounds.	
559	sacks bread.	
76	sacks castor-beans.	
19	sacks buckwheat.	
32	tons scrap-iron.	
103	express freight measurement, equal to 62 tons weight.	

Total weight 7,050 tons.

WILMINGTON OFFICE, LOS ANGELES, CALIFORNIA, JANUARY 1, 1871.

Imports during A. D. 1870.

17, 171	tons assorted merchandise and measurement, equal to 10,303 tons weight.
266	tons express freight and measurement, equal to 135 tons weight.

59	wagons and buggies.
280	head sheep.
41	head horses and cattle.
1,096	empty pipes and puncheons.
693	empty barrels.
87	cords wood.
1,280	bales hay, 162 tons.
5,860,005	feet assorted lumber.

Total weight 10,600 tons, and 5,860.005 feet assorted lumber.

Total tons merchandise received and shipped, 17,550. Weight exclusive of lumber.

Vessels arriving, delivering, and receiving freight at this port during the year, 147 steamships and 56 sail-vessels.

I certify the foregoing to be a correct statement of exports and imports during the year 1870.

Report examined and approved.

E. C. HEWITT,
Superintendent.
GEORGE R. TURMAN,
Freight Clerk.

B.

FIRST CONSTRUCTION.

Estimate for 100 *feet, using untreated lumber.*

	Feet.	
40 square piles, 25 feet by 12 by 12	12,000	
80 sheet-piles, 25 feet by 12 by 6	12.000	
80 sheet-piles, 25 feet by 12 by 4	8,000	
110 feet wales, 12 by 12 inches	1,320	
110 feet wales, 8 by 12 inches	880	
220 feet wales, 8 by 8 inches	1,175	
	35,375, at $30	$1,061 25
Driving 40 piles, at $4 50		180 00
Driving 160 sheet-piles, at $2 25		360 00
100 running feet carpentering, at $1 50		150 00
800 pounds bolts, at 9 cents		72 00
		1,823 25
Divide by 100		$1,823. 25
Add 10 per cent		1 80
Cost per foot		20 00
Cost of 3,080 feet, at $20		$61,600 00

THIRD CONSTRUCTION.

Estimate for 100 *feet, with treated timber.*

	Feet.	
40 piles, 25 feet by 12 by 14 inches	14,000	
160 piles, 25 feet by 12 by 12 inches	48,000	
20 brace, 25 feet by 12 by 12 inches	6,000	
440 feet wales, 12 by 12 inches	5,280	
40 braces	3,300	
110 feet wales, 8 by 12 inches	880	
100 feet wales, 6 by 12 inches	660	
Joints and covering	6,520	
	84,640, at $40	$3,385 60
Driving 220 piles, at $3 50		770 00
100 feet carpentry, at $2 50		250 00
6,160 pounds iron bolts, at 9 cents		554 40
350 yards stone, at $4		1,400 00
		6,360 00

Divide by 100—cost, per foot	$63 60
Add 10 per cent	6 36
	70 00

FOURTH CONSTRUCTION.

Estimate for crib 30 feet by 20 by 12 feet 6 inches.

	Feet	
2 pieces, 30 feet by 12 by 18 inches	1,080	
2 pieces, 20 feet by 12 by 18 inches	720	
30 pieces, 30 feet by 12 by 12 inches	10,800	
44 pieces, 20 feet by 12 by 12 inches	10,560	
	23,160, at $40..	$926 40
Carpentry		225 00
Iron bolts, 1,120 pounds, at 7 cents		78 40
183 yards stone filling, at $4		732 00
Labor		50 00
		2,011 80
Divide by 30	$67	60 per foot.
Cost of 30 cribs, 16 feet high, other dimensions the same, per foot		$82 00
Add 10 per cent. per foot		8 00
		90 00

FIFTH CONSTRUCTION.

Estimate for 100 feet, with treated timber.

	Feet.	
60 piles, 30 feet by 12 by 12 inches	21,600	
220 wales, 12 by 12 inches	2,540	
220 wales, 8 by 8 inches	1,150	
800 planking, 6 by 12 inches	4,800	
80 sheet-piles, 30 feet by 6 by 12 inches	14,400	
80 sheet-piles, 30 feet by 4 by 12 inches	9,600	
Braces	400	
	54,490, at $40..	$2,179 60
Driving 60 piles, at $3 50		210 00
Driving 160 piles, at $2 25		360 00
2,000 pounds bolts, at 9 cents		180 00
205 pounds bolts, at 7 cents		15 05
Carpentry, 100 feet, at $2 50		250 00
		3,194 65
Divide by 100—cost per foot		$31 94
Add 10 per cent		3 06
		35 00

Estimate for 6,700 feet of construction for Wilmington Breakwater.

*3,080 feet of construction, No. 1, at $20 per foot	$61,600 00
550 feet of construction, No. 5, at $35 per foot	19,250 00
1,500 feet of construction, No. 3, at $70 per foot	105,000 00
1,570 feet of construction, No. 4, at $90 per foot	141,300 00
	337,150 00
Add for contingencies	62,850 00
	400,000 00
Amount of the present appropriation	200,000 00
Additional amount required	200,000 00

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* X to Y, 3,080 feet.

W 11.

Annual report for the breakwater at Wilmington, California, for the year ending the 30th June, 1871.

SAN FRANCISCO, CALIFORNIA, *July* 31, 1871.

Under the instructions of the Engineer Department, dated the 22d March, 1871, an examination and partial survey of the harbor of Wilmington was made in the months of April and May.

A report and plan for the proposed improvement of the harbor, based upon the results of this examination, was submitted on the 15th June.

Under date of the 1st July the project was approved in part by the Chief of Engineers, and orders given to contract for the first division of the line, about 3,630 feet in length.

By subsequent telegraphic authority from the Chief of Engineers, dated the 14th July, engagement was made in open market for the timber, to be delivered at San Pedro anchorage.

By the same authority, bids have been invited for the construction of this first division. These bids will be opened on the 14th August, and the work advertised is to be completed by the 1st day of March, 1872.

After this part of the construction is inaugurated, preparations will be made to construct the remaining portion so far as the available funds will permit.

Respectfully submitted.

G. H. MENDELL,
Major of Engineers.

The CHIEF OF ENGINEERS, U. S. A.,
Washington, D. C.

APPENDIX X 1.

OFFICE OF WASHINGTON AQUEDUCT,
Washington, D. C., September 30, 1871.

GENERAL: I have the honor to make the following report for the last year concerning the Washington Aqueduct:

THE DAM AT GREAT FALLS.

The permanent dam extending across the Maryland channel, or from a point near the head of the aqueduct to Conn's Island, remains in excellent condition, and has required no repairs during the year. There was an appropriation of $5,500, available for expenditure during the last fiscal year, for removing the obstructions in the river above the dam, which prevented the free access of the water to the head of the aqueduct. These consist of some low, grassy islands and rocks, and ledges. When I took charge of the aqueduct, in November last, there was a party of workmen engaged at this point, but the water in the river, soon after, had risen so much that the work could no longer be prosecuted to advantage, and I suspended operations at this point till the low water of the present season. On the 15th of July the water had subsided so that work could be resumed, and it will be continued till the appropriation is exhausted, unless high water should interfere. It is believed that the work done and to be done, under the appropriation, will effectually remove the difficulty which existed, and that the supply of water to the aqueduct will be sufficient for many years, and for a large increase in the population of the District. Before the full capacity of the conduit, nearly 100,000,000 gallons per day, (a supply sufficient for a population of more than half a million, besides furnishing a great amount of water-power,) can be realized, an extension of the dam across the Virginia channel, according to the original design, will probably be necessary.

CABIN JOHN BRIDGE.

My estimates for the parapets of this bridge, Griffith Park Bridge, and the two others on the line of the conduit, were $20,000, but Congress reduced the amount in the appropriation to $10,000. The coping for this bridge has not been laid, and it is necessary before any kind of a parapet or railing is placed. The appropriation is for "*completing coping and iron railing*," but it is not sufficient for even an iron railing of the strength required for the narrow and elevated roadway over the bridge. I recommend that the coping be purchased and laid with the existing appropriation, and that the balance be retained in the hope that Congress will grant an additional amount. An iron railing is not suitable for this bridge, which is much used by the heavy teams from Montgomery County, and is so narrow that there is barely room for two to pass each other.

I have designed an open-work brick parapet, to be covered with stucco, which will not cost more than a heavy iron railing, and will be in keeping with the character of this elevated structure. The roadway is but 14 feet wide, and is 90 feet above the creek, and the parapet should not only be strong enough to prevent accidents in cases of horses becoming frightened on the bridge, but should have the *appearance of strength* which an iron railing, liable to be struck by the hubs of wheels of vehicles, would not have. Probably the parapets should be of stone to be commensurate with this celebrated bridge.

THE TUNNELS ON THE LINE OF THE CONDUIT.

Tunnel No. 1 (near Great Falls) is not lined by an arch, and some rocks fell some years ago from the roof to the floor, and they interfered somewhat with the waterway. There is an appropriation of $1,500 available for their removal, but the supply by the conduit to the District could not well be interrupted up to the present time on account of the work at the reservoirs, and the water has not yet been drawn off, which is necessary for the removal of the rocks. As soon as the storage reservoirs are completed, and the supply from the river can be stopped for a few days, these rocks will be removed. The other tunnels are all in good condition.

THE CONDUIT.

The conduit remains in excellent condition. In February last I raised the water in the distributing reservoir to the height of 145 feet above the datum level, or to the flow-line of the reservoir as originally designed This produced a pressure on the soffit of the conduit arch, (of three feet of water at the effluent end,) and, as was to be expected from the unequal character of the foundations of the conduit, there were some small leaks discovered where it rests in embankment. These were repaired with cement, and no trouble has since been discovered.

There was an appropriation of $10,000 for the fiscal year 1870–'71 for macadamizing the conduit road, to prevent the traffic, which is considerable, between Montgomery County, Maryland, and the District, from cutting through the earth and injuring the extrados of the arch. Under this appropriation there were macadamized 16,872 running feet of the road, and stone was hauled and distributed along the road sufficient to macadamize about 2,800 feet more. In addition to the macadamizing, there was a large amount of work done in raising and widening the embankment over the conduit. There was made, by act of March 3, 1871, a further appropriation of $10,000 for continuing this work, which is now in progress, and it is believed that it will protect all of the road which requires any expenditures upon it.

THE DALECARLIA TUNNEL.

The arching of this tunnel, which connects the conduit above with the conduit below the receiving reservoir, and was constructed so that the daily supply of water could be led from the Potomac directly into the city or into the distributing reservoir whenever the water of the receiving reservoir is turbid, or otherwise unfit for use, (which it sometimes is after storms on account of its being surrounded by cultivated hills,) was in progress by my predecessor when I took charge of the aqueduct, and soon after that date was finished.

THE RECEIVING RESERVOIR.

The balance of the appropriation available for the protection of the banks of the reservoir will be expended as soon as the other works now on hand will permit, in constructing the wing-walls at the outlet of the conduit into the reservoir, and if any money should remain when these are completed, it will be expended on the water-face of the dam. This reservoir will then be completed.

On the 20th of June last, the fetid taste and smell of the water consumed in the District attracted the attention of every citizen. It remained for several days, and passed off as mysteriously and as rapidly as it came. It is not an unusual circumstance in water-works, but the causes of it do not seem to be very well understood. The generally received opinion is, however, that it arises from the confervæ which, under favorable circumstances, are generated in all reservoirs. The large area of shallow water in the receiving reservoir conduces to their growth, and it and the turbid condition of the water after showers, arising from several small streams which flow into it, and from the cultivated ground around it, render this reservoir unreliable as a source of supply, and as a rule the water from the Potomac should flow through the Dalecarlia tunnel, and not through this reservoir. It is frequently the case, however, when the water of the Potomac is turbid, that the reservoir is clear, and it will always be required for storage purposes, to be used from in case of accident to the works above, or of the impure condition of water in the Potomac. Under an act of Congress approved by the President on the 6th of May, 1870, the lands about the reservoir, or so much of them as were not required for the purposes of the aqueduct, were to be set off for the use of the Reform School. The boundaries of the lands to be set off have been surveyed, and as soon as the plat can be copied it will be transmitted for the approval of the War Department.

THE DISTRIBUTING RESERVOIR.

Work on this reservoir was commenced on the 13th of April last. Contracts were made at reasonable prices for the slope-walls for the protection of the dams, and for the labor necessary to put the latter in condition to receive the walls. The reservoir has been used for some years without any protection to the dams, and they had become much washed by the waves, so much so that the eastern dam had been nearly one-half washed away. There have been about 2,796 cubic yards of slope-wall and its broken-stone foundation laid by the contractors, and there are about 5,888 yards yet to be laid by them. The houses for the water-gates are under construction, and the entire reservoir will be finished by the time the contractors have completed their contract for finishing the slope-wall. The public land at this reservoir will be fenced, trees will be planted outside the dams, the tops and slopes of the dams will be sown in grass, and it is believed that this will soon be one of the most attractive spots in the District.

THE HIGH-SERVICE RESERVOIR IN GEORGETOWN.

The appropriation for this reservoir was, for the fiscal year 1870–'71, $4,000, and for the fiscal year 1871–'72, $4,000.

Plans were prepared for an ornamental iron cornice at the top of the unfinished domical arch over the reservoir, and for an iron fence around the lot, when I received a petition from citizens in the neighborhood that the dome be taken down and an iron fence be built upon the reservoir wall. The top of the reservoir, as designed, would require the dome to be completed to the top, following the rule in Europe of covering reservoirs in cities to protect them from the sun, and especially from the dust from the streets. My design is a compromise between the wishes of the citizens in the neighborhood and the original, and I am convinced that, when it is finished, the reservoir will be an ornament to that part of Georgetown, and the objections of the protestants will be removed. As soon as the iron-work is finished, the exterior of the arch will be covered with stucco.

PURCHASE OF LANDS.

The following sums have been paid during the last year for lands which have been used for some years by the United States for aqueduct purposes, and in all cases they include the rents that had accrued:

For two lots of land at the high-service reservoir in Georgetown	$3,300 00
For 5.44 acres of land at Great Falls	1,320 00
For 18,581 square feet of land at the tubular aqueduct bridge across Rock Creek	2,639 98
For 1.66 acres of land near the receiving reservoir	342 55

There was also appropriated, by act of Congress approved 15th July, 1870, $1,012 for the purchase of roadway between the head of the conduit road and the Great Falls, but the owners, with one exception, were so unreasonable in their demands that the purchases were not completed before the 1st day of July last, at which date the balance of the appropriation lapsed into the Treasury.

THE NEW 36-INCH MAIN FROM THE DISTRIBUTING RESERVOIR TO CAPITOL HILL.

The laws of Congress in relation to this are as follows:

SEC. 6. *And be it further enacted*, That whenever it shall become necessary to lay main pipes for the supply to the cities of Georgetown and Washington, the cost of the same shall be paid by the said cities, and the engineer aforesaid is hereby prohibited from making any contracts for the same, unless approved by the corporations aforesaid, and expressly stipulated with the contractor or contractors that the payment for the same is to be made by the said corporations.

Approved by the President March 3, 1859.

SEC. 4. *And be it further enacted*, That the said engineer officer shall cause to be furnished and laid, from the distributing reservoir of the Washington Aqueduct to Capitol Hill, in the city of Washington, along such route as he shall determine, an iron main of 36 inches in diameter, connected with the present mains, at such points as he shall direct, and that the entire cost thereof shall be borne apportionately by the corporations of Washington and Georgetown; and in order to provide for such cost, the said corporations are hereby empowered and authorized to increase the present water-rates and water-taxes to such an amount as may by them be deemed necessary.

SEC. 5. *And be it further enacted*, That for the purpose of enabling the corporations aforesaid to carry out the provisions of this act, it shall be competent for them to borrow, in such proportions as they may deem necessary, a sum of money not exceeding two hundred and sixty thousand dollars for the city of Washington and forty thousand dollars for the city of Georgetown, redeemable within a period of ten years out of any revenue to be derived from water-rents.

Approved by the President July 14, 1870.

The attention of the governments of Georgetown and Washington was brought to this matter by letter and estimate which I submitted on the 13th of January, 1871. But no appropriation was made till the new territorial government passed the act of July 20, 1871, appropriating $450,000 for this main, for a 30-inch main on New Jersey avenue, and for a 20-inch main on Capitol Hill. The specifications and drawings having been made, invitations for proposals for furnishing the 36-inch main from the reservoir to New Jersey avenue (which will require about 9,000,000 pounds of iron) were invited by circular and advertisement on the 24th of July last. The bids were opened on the 15th of August. It being found that the lowest bid (though made in good faith and though the contract was claimed under it by the bidder) was informal, I referred the question, as to my power to accept it, for the decision of the Attorney General of the United States. That officer having decided that I could not accept the lowest bid, and the difference between it and the next bid being so great, (about $25,000,) I determined, after conference with Governor Cooke, to reject all the bids and readvertise, which I did on the 25th ultimo, and bids were opened anew on the 5th instant. Considering the disappointments and delays in the furnishing of pipe to those cities which had no recourse for damages except by means of suits on the bonds of the contractors, and the urgent necessity of an immediate increased supply, I gave notice in my readvertisement that I should provide in the contract, in addition to the bond, *a penalty of one dollar a day for each and every pipe not delivered on the 1st of February next*, to be deducted from any moneys due the contractors. On the second opening of bids there were four which, considering the estimated quantities, amounted to the following sums:

Jesse W. Starr & Sons, Camden, New Jersey	$284,926 07
William Smith, Pittsburgh, Pennsylvania	285,064 82
R. D. Wood & Co., Philadelphia, Pennsylvania	288,050 10
The Gaylord Iron Pipe Company, Cincinnati, Ohio	301,633 10

The award was made, with the approval of the governor, to the lowest bidders. Invitations for tenders for *laying the pipe* having been advertised, the latter were opened on the 15th instant. There were twelve bids, the lowest being those of Emmart, Dunbar & Co., (for the reservoir, the east and the west Washington divisions,) and O'Hare, Himber & Co., (for the Georgetown division,) at prices which, considering the estimated quantities, amount to $61,801 30 for the whole line. The awards having been made to the parties just named, they have signed the contracts and given the required bonds. These contracts require that they shall have the entire line laid and completed within thirty days from the time the pipe shall have been furnished by the pipe-founders, under heavy penalties. This time, as before stated, is the 1st of February, so that we may confidently expect to have, by the *1st day of March next*, the full benefit of the eighteen millions of gallons a day additional which the new main will bring to the city, although, as the connections will be made as fast as the new main is laid between it and the 30-inch main, an increased supply may be expected before that date.

I have information that the pipe-founders, at this time of year, have engagements for pretty much their entire capacity, and the 9,000,000 pounds for the 36-inch main will be about as much as can be advantageously taken from the market this season.

I propose, therefore, to delay invitations for proposals for furnishing the remainder of the pipe (the 30-inch and the 20-inch) till later in the season, so that it can be made during the winter, and laid early in the spring. It is believed that it can be obtained in this way at considerable less cost than if it should be attempted to lay it this season; and I am further induced to this decision by the fact that the laying of the 36-inch pipe to New Jersey avenue will relieve the want of water everywhere in the city.

In conclusion, I believe that the existing appropriations will be sufficient for the final completion of the aqueduct, except as follows:

1. The original design of General Meigs, as before stated, was to continue the dam across the Virginia channel of the Potomac, and it will probably have to be done before the full capacity of the conduit can be realized, but that capacity will not be required for many years to come.

2. The distributing reservoir is so shallow that it is probable it may at some future time require to be deepened. Shallow water is favorable to the growth of vegetable matter in reservoirs, especially in the summer months, and it is usually avoided by making them of depths sufficient to prevent it. The expense of this deepening has in former years been estimated at $241,405. I do not recommend an appropriation for this purpose at this time, for the reason that since I have had charge of the work this reservoir has been empty on account of the work in progress, viz: the houses for the water-gates, and the slope-walls for the protection of the dams against the waves, so that I have not had an opportunity of observing the condition of the water in the summer months. When this reservoir is otherwise finished, as it will be, by means of existing appropriations, and the water has been turned in, if the same effect of shallow depth as was observed in the receiving reservoir last summer is found in this in the hot months, which I do not anticipate, on account of the greater depth of the latter, it will be time enough to recommend an appropriation for deepening it.

3. Gate-keepers for regulating the flow in the conduit are and will always be required at Great Falls and at the reservoirs. The cabins in which they now live are small and uncomfortable, and are not of a style commensurate with the other parts of the grandest system of water-works of which any of our cities can boast. A new house should be constructed at the distributing reservoir, and the others should be repaired.

4. On other long lines of water-works like this telegraphs are maintained, which connect the houses for the water-gates with the office of the superintendent. They are of simple dial variety, such as are used by

private corporations in all cities for transmitting messages between manufacturing and other establishments and their offices. There are several in use in Washington. Their utility on the aqueduct is manifest, for in case of sudden floods in the river, or of accident on the line at any time, word could be transmitted in a moment to different gate-keepers, and to the office of the superintendent, avoiding the damage which may at any time result from delay in sending messengers on foot along the long line of these works. The machine referred to is comparatively inexpensive, and I respectfully recommend an appropriation for its purchase, and for the erection of the poles and wires.

5. There should be a further appropriation for the completion of the parapets of the bridges on the line of the conduit, for reasons stated under the head "Cabin John Bridge."

My estimates of appropriations which should be made for the next fiscal year are therefore as follows:

1. For dwellings for the keepers of the water-gates	$5,000
2. For completing the parapets of Cabin John and the other bridges on the line of the conduit	10,000
3. For a dial telegraph connecting Great Falls with the reservoirs and with the office in Washington	3,500
4. For maintenance (including salaries of gate-keepers) and general repairs	12,000
Total	30,500

The following is a money statement for the last fiscal year.

Financial Statement for the fiscal year ending June 30, 1871.

Titles of appropriations.	Amount appropriated.	Expended in 1870-'71.	Available July 1, 1871.
Superintendence and general repairs	$12,000 00	$12,000 00	....
Arrears of superintendence and repairs	4,000 00	3,993 40	$6 60
Completing arch at high-service reservoir	4,000 00	130 00	3,870 00
Macadamizing top of conduit road	10,000 00	10,000 00	....
Slope-wall of distributing reservoir	30,000 00	4,517 67	25,482 33
Completing two gate-houses at distributing reservoir	20,000 00	1,408 40	18,591 60
Repairing embankments at distributing reservoir	5,000 00	4,999 99	1
Preserving new, or Dalecarlia tunnel	20,000 00	17,595 16	2,404 84
Repairing tunnel No. 1, and removing fallen stones	1,500 00	337 60	1,162 40
Cleaning out obstructions near dam, head of aqueduct	5,500 00	2,920 13	2,579 87
Rent and purchase of land at high-service reservoir	3,300 00	3,300 00	....
Rent and purchase of land at bridge No. 6	2,640 00	2,639 98	2
Purchase of road-way from Great Falls to conduit road	1,012 00	221 00	791 00
Purchase of road-way across land of William Brooke	550 00	....	550 00
Rents and purchase of 5.44 acres of land	1,320 00	1,320 00	....

Herewith please find the report of my assistant, Theodore B. Samo, esq., and copies of the laws of Congress in relation to the Washington Aqueduct up to the present time, which I have to request may be printed with this report.

Respectfully submitted,

GEORGE H. ELLIOT,
Major of Engineers United States Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

OFFICE OF WASHINGTON AQUEDUCT,
Washington, D. C., September 30, 1871.

MAJOR: I have the honor to submit the following report of operations upon the Washington Aqueduct during the year ending September 30, 1871:

At Great Falls, at the date of the last annual report, a force was engaged in removing rocks, trees, and bushes from the Maryland channel of the Potomac River, between the dam and the head of Conn's Island. This work was suspended in November in consequence of high water, and was not resumed until last July. Since then it has slowly progressed, owing to the difficulty of getting men to work in that locality.

The Potomac dam was recently examined, and found to be in good condition.

No repairs have been made on it since its completion, in 1867, and it has sustained no damage, except a washing of the cement from some of the joints by the freshets of the river.

The conduit is generally in good condition. The roadway over it was partly macadamized last year. The amount of appropriations for this purpose was $10,000. The work was continued until the middle of last January, when the appropriation was expended.

The length of roadway macadamized was 16,872 lineal feet, and sufficient stone was delivered along the road to macadamize 2,800 feet more.

Congress during its last session having made another appropriation for this purpose, the work was resumed in July, and has rapidly progressed. It is estimated that the present appropriation will complete the macadamizing from the distributing reservoir to Griffith's Park Bridge.

At the receiving reservoir the lining of Dalecarlia tunnel with bricks was completed in December. The protection of the slopes of the connecting conduit embankments with quarried stones was nearly completed, the total length of slopes protected being 1,138 feet.

The timbers and planks that formed the centering for the arch of Dalecarlia tunnel were removed; also the planks forming the runway. These were used in building a new walk in the tunnel leading to waste-weir No. 2, the old one being decayed and dangerous.

After the completion of Dalecarlia tunnel, the Potomac water was allowed to flow direct from the river into the distributing reservoir. On the 25th of January the surface of water in the reservoir was raised from +140 of the Washington Aqueduct levels to +145. With the water at this elevation in the reservoir, it is 8 feet deep in the conduit at Cabin John Bridge, and 8½ feet at culvert No. 18. In the conduit at the influent gate-house of the distributing reservoir, it is full and under a pressure due to a head of 3.13 feet. In consequence of raising the water to this elevation leaks occurred in the conduit over culverts Nos. 18, 19, 20, and 21, and at culverts 25 and 26. In February the water was drawn from the conduit, and the leaks were repaired. Since then the surface of water at the distributing reservoir in the conduit has been kept at +142.

During the winter plans and specifications, with forms of contracts, were made under your directions for the slope-wall and gate-houses of the distributing reservoir.

In March the reservoir was emptied out in order to begin the construction of the slope-wall. This was commenced in April, and has progressed during the past season in a satisfactory manner, the total amount of work done September 1 being as follows:

Slope-wall, 2,825 cubic yards; broken-stone lining, 1,397 cubic yards.

The amount of wall yet to be built is about as follows:

Slope-wall, 5,888 cubic yards; broken-stone lining, 2,944 cubic yards.

Work has also been commenced on the influent and effluent gate-houses and the stair well-house; all of which will be finished during the present season.

The dams of the reservoir and the division embankment were much damaged by the waves, owing to the reservoir being used in its unfinished condition for several years for the storage and settling of water. The eastern dam was washed away for nearly one-half of its thickness, and the division embankment was fully two-thirds destroyed. They have been thoroughly repaired with clay excavated from the bottom of the reservoir.

Cabin John Bridge, Griffith's Park Bridge, and bridges Nos. 1 and 2 remain unfinished. An estimate of the cost of completing them was $20,039. The amount appropriated was only $10,000. This sum is not sufficient to finish Cabin John Bridge in a manner commensurate with its magnitude and grandeur.

Surveys and plans were made of the lands occupied for aqueduct use, and to which the United States had no title.

The pipe-line of the Washington Aqueduct is generally in good condition. During the past year very few leaks have occurred. In Washington the 12-inch main was lowered in Fifteenth street in front of the Treasury Department. This was necessary in consequence of the grade of the street being altered by the corporation authorities. The main was lowered for a distance of 600 feet to an average depth of 4 feet. This was successfully accomplished without shutting off the water, and the expense incurred was paid by the corporation. The 12-inch main was also lowered over Tiber Creek, in Pennsylvania Avenue.

College Pond Bridge is in good condition. The wood-work of Rock Creek Bridge has been entirely renewed. The floor was worn out, and on removing it the floor-beams were found to be decayed. New ones were put in place, and a flooring of white-oak laid thereon.

The Worthington water-pressure engine, in the west abutment of Rock Creek Bridge, has been stopped several times for repairs. It is now in good condition. This engine, for a number of years, has supplied Georgetown Heights with Potomac water. The quantity supplied being inadequate, permission was given to the Georgetown authorities to place a steam-pump and boiler in connection with the 30-inch main and the high-service forcing-main. Since this was done the supply to the high-service has been abundant.

Plans and specifications were made and a contract entered into for completing the high-service reservoir. The work has been begun, and it will be finished during the present year. The plan adopted for its completion will very much improve its present unsightly appearance.

Congress, in 1870, having ordered that a new main of 36 inches in diameter should be laid from the distributing reservoir to Capitol Hill, and connected with the United States mains, the expense thereof to be borne by the cities of Washington and Georgetown, the attention of the authorities of each city was called by you to the requirements of the law, and an estimate of the probable cost of the main was submitted. No positive action on the subject was taken by either city.

Under your directions, plans, estimates, specifications, and forms of contract, both for furnishing and laying the main, were prepared. On the 20th of July the legislature of the District of Columbia passed a law providing for the paying of the cost of the main, and authorizing its construction. Advertisements were immediately issued inviting proposals for furnishing the pipes and appurtenances. Advertisements have also been issued inviting proposals for laying the pipes, and there is every probability that the work will soon be under contract, and rapidly pushed to completion.

Much labor was expended in determining the thickness to be given to the iron of the pipes, in preparing the estimates, and the plans, specifications, and contracts, but not more than the importance of the subject demanded.

Very respectfully, your obedient servant,

THEODORE B. SAMO,
Assistant Engineer Washington Aqueduct.

Major GEORGE H. ELLIOT,
Corps of Engineers, U. S. A., Chief Engineer Washington Aqueduct.

LAWS OF CONGRESS RELATING TO THE WASHINGTON AQUEDUCT.

The first enactment by Congress in relation to this work is found on page 92, volume 10, Statutes at Large, in the general appropriation bill, approved April 30, 1852, which reads as follows:

"To enable the President to cause the necessary surveys, projects, and estimates to be made for determining the best means for affording the cities of Washington and Georgtown an unfailing and abundant supply of good and wholesome water, report thereof to be made to Congress at its next session, the sum of five thousand dollars, or so much thereof as may be found necessary."

The second enactment is found on page 206, volume 10, Statutes at Large, in the general appropriation bill, approved March 3, 1853, which reads as follows:

"To be expended under the direction of the President of the United States, for the purpose of bringing water into the city of Washington, upon such plans and from such places as he may approve, one hundred thousand dollars: *Provided*, That if the plan adopted by the President of the United States should require water to be drawn from any source within the limits of Maryland, the assent of the legislature of that State shall first be obtained."

The third enactment is found on page 664, volume 10, Statutes at Large, in the general appropriation bill, approved March 3, 1855, which reads as follows:

"For continuing the work on the Washington Aqueduct, two hundred and fifty thousand dollars."

The fourth enactment is found on page 86, volume 11, Statutes at Large, in the appropriation bill for certain civil expenses, approved August 18, 1856, which reads as follows:

"For paying existing liabilities for the Washington Aqueduct, and preserving the work already done from injury, such sums of money as shall be necessary, not exceeding two hundred and fifty thousand dollars."

The fifth enactment is found on page 225, volume 11, Statutes at Large, in the appropriation bill for certain civil expenses, approved March 3, 1857, which reads as follows:

"For continuing Washington Aqueduct, one million dollars."

The sixth enactment is found on page 256, volume 11, Statutes at Large, and reads as follows:

"*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the Secretary of the Treasury shall settle and adjust with all the parties respectively interested therein, on principles of justice and equity, all damages, losses, and liabilities incurred or sustained by said parties respectively, on account of their contract for manufacturing brick for the Washington Aqueduct; and he is hereby directed to pay the amount found due by such settlement and adjustment, out of the appropriation made for paying the liabilities for the said aqueduct, by the act 'making appropriations for certain civil expenses of the Government for the year ending June thirtieth, eighteen hundred and fifty-seven,' approved the eighteenth of August, eighteen hundred and fifty-six: *Provided*, That the said parties first surrender to the United States all the brick made, together with all the machinery and appliances, and other personal property prepared for executing the said contract, and that the said contract be canceled.

"Approved March 3, 1857."

The seventh enactment is found on pages 263, 264, and 265, volume II, Statutes at Large, and reads as follows:

"AN ACT to acquire certain lands needed for the Washington Aqueduct, in the District of Columbia.

"Whereas it is represented that the works of the Washington Aqueduct, in the District of Columbia, are delayed in consequence of the proprietors' refusal, in some cases, to sell lands required for its construction at reasonable prices, and because, in other cases, the title to the said land is imperfect, or is vested in minors, or persons non compos mentis, or in a femme covert, or [in persons] out of the District of Columbia; and whereas it is necessary for the making of the said aqueduct, reservoirs, dams, ponds, feeders, and other works, that a provision should be made for condemning a quantity of land for the purpose: Therefore,

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That it shall and may be lawful for the United States, or its approved agent, to agree with the owners of any land in the District of Columbia, through which said aqueduct is intended to pass, for the purchase or use and occupation thereof; and in case of disagreement, or in case the owner thereof shall be a femme covert, under age, non compos, or out of the District of Columbia, on application to a judge of the circuit court of said District, the said judge shall issue his warrant, under his hand, to the marshal of the said District to summon a jury of eighteen inhabitants of said District not related to the parties, nor in any manner interested, to meet on the land to be valued, at a day to be expressed in the warrant, not less than ten nor more than twenty days thereafter; notice of the time and place of said meeting being first given to the owners of such land or to their legal representatives, in person if that be practicable, and, if not, by publication in some Washington City newspaper daily for two weeks; and the marshal, upon receiving the said warrant, shall forthwith summon the said jury, and, when met, shall administer an oath or affirmation to every juryman who shall appear, being not less than twelve in number, that he will faithfully, justly, and impartially value the land, and all damages the owner thereof shall sustain by cutting the aqueduct through such land, or the partial, or temporary, or permanent appropriation, use, or occupation of such land, according to the best of his skill and judgment; and that in such valuation he will not spare any person for favor or affection, nor any person grieve for malice, hatred, or ill-will; and the inquisition thereupon taken shall be signed by the marshal and four-fifths of the said jury, and [be] returned by the marshal to the circuit court for the District of Columbia; and, unless good cause be shown against the said inquisition, it shall be affirmed by the court at its first term after said return and [be] recorded; but if, from any cause, no inquisition shall be returned to such court within one month after the commencement of the next ensuing term, the said court [shall], at its discretion, as often as may be necessary, direct another inquisition to be taken in the manner above prescribed; and upon every such valuation the jury is hereby directed to prescribe and ascertain the bounds of the land by them valued, and the quantity and duration of the interest and estate in the same required by the said United States for the use of the aqueduct, and their valuation shall be conclusive on all persons, and shall be paid for by the said United States, or its authorized agent, to the owner of the land, or his, or her, or their legal representative; and, on payment thereof, the said United States shall be seized of such land as of an absolute estate in perpetuity, or with such less quantity and duration of interest or estate in the same, or subject to such partial or temporary appropriation, use, or occupation as shall be required and desired as aforesaid, as if conveyed by the owner to the said United States; and whenever, in the construction of the said aqueduct, or any of the works thereof, reservoirs, dams, ponds, feeders, tunnels, aqueducts, culverts, bridges, or works of any other description whatsoever appurtenant thereto, it shall be necessary to use earth, timber, stone, or gravel, or any other material to be found on any of the lands adjacent or near thereto, and the said United States or their agent cannot procure the same for the works aforesaid by private contract of the proprietor or owner; or in case the owner should be a femme covert or non compos, or under age, or out of the District, the same proceedings, in all respects, shall be had as in the case before mentioned of the assessment and condemnation of the lands required for the said aqueduct or the work appurtenant thereto: *Provided*, That the work shall not be delayed pending any such proceeding in court, but the same shall be continued without obstruction thereby, after the inquisition shall be returned to the court.

"SEC. 2. *And be it further enacted*, That it shall and may be lawful for the United States or its agent, in case of any dispute or difficulty arising as to the ownership of the land condemned as above for the use of said aqueduct, or in case the owner should be a femme covert, under age, non compos, or out of the said District of Columbia, and no person duly authorized to receive the same, that the United States or its agent be authorized, by petition to the circuit court for the District of Columbia, and upon said court's order, to deposit the money for which the said land was condemned in the place directed by said court, and the certificate of the proper officer of said deposit shall be considered as a full payment for said land, and thereby vest in the United States an absolute estate in perpetuity, or with such less quantity and duration of interest in the same, as subject to such partial, or temporary, or permanent use or occupation as shall be required and described as aforesaid, if conveyed by the owner or owners of said land.

"SEC. 3. *And be it further enacted*, That it shall be the duty of said circuit court to hear and determine to whom the said money does belong, and, upon being satisfied as to whom the land did belong, to pass their decree directing the clerk of said court to pay over to the owner the same money deposited as above, after deducting expenses. The court is further authorized to direct the mode for trying the case, and the litigants have the right of appeal, provided the appeal is taken within sixty days from the decree of the said court.

"Approved April 8, 1858."

The eighth enactment is found on page 323, volume 11, Statutes at Large, in the appropriation bill for sundry civil expenses, approved June 12, 1858, and reads as follows:

"For the completion of the Washington Aqueduct, eight hundred thousand dollars, and, in addition thereto, so much of the appropriation of two hundred and fifty thousand dollars 'for paying existing liabilities for the Washington Aqueduct, and preserving the work already done from injury,' contained in the act entitled 'An act making appropriations for certain civil expenses of the Government for the year ending the thirtieth June, eighteen hundred and fifty-seven,' approved eighteenth August, eighteen hundred and fifty-six, as may not be required for said purposes."

The ninth enactment is found on page 435, volume 11, Statutes at Large, approved March 3, 1859, entitled "An act to provide for the care and preservation of the works constructed by the United States for bringing the Potomac water into the cities of Washington and Georgetown, for the supply of said water for all governmental purposes, and for the uses and benefits of the inhabitants of said cities," which reads as follows:

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the dams, aqueducts, water-gates, reservoirs, and all fixtures and improvements connected therewith, which have been or hereafter may be constructed by the United States for the conveyance of water from the Potomac River, above the Great Falls, to the cities of Washington and Georgetown, together with the lands, houses, fencing, water, and other rights and appurtenances connected with the same, and belonging to the Government, as also the mains, conduits, supply-pipes, basins, hydrants, fountains, stop-cocks, sewers, drains, receiving-basins, and all other fixtures connected with the same, which have been or hereafter may be laid down or constructed by the United States, shall be placed by the President of the United States under the immediate care, management, and superintendence of a properly qualified officer of the United States Corps of Engineers, to be appointed by him, who shall act under the Department of the Interior, and who shall make an annual report to that Department in the month of November in each year, to be laid before Congress at the commencement of their regular annual session, of the work, proceedings, repairs, casualties, and expenditures connected with the said water-works for the preceding year; and such officer, as a compensation for the duties and responsibilities imposed upon him by this act, shall receive for his pay as said engineer no more than his regular pay as an officer of the corps. He shall occupy the necessary apartments in one of the public buildings in the city of Washington as may be directed by the President, and shall be supplied by the Government with the stationery, instruments, books, and furniture required in the performance of his public duties, and in this office of the Engineer of the Potomac water-works shall be kept and preserved a complete record of all the lands and other property, and matters and things enumerated in this section, and otherwise connected with or belonging to these water-works, or which may hereafter be acquired or procured for the same. The said engineer shall have full power and control over the said water-works, and shall regulate the manner in which the said corporations of Washington and Georgetown may tap the pipes for the supply thereof, and shall stop the same whenever it is found no more than adequate to meet the wants of the General Government. The said engineer's decision on all questions connected therewith to be subject only to appeal to the Secretary of the Interior.

"SEC. 2. *And be it further enacted*, That full power and authority are hereby given to the corporations of Washington and Georgetown, in the District of Columbia, to supply the inhabitants within their respective limits with Potomac water from the aqueduct, mains, or pipes now laid or to be laid in the streets or avenues by the United States; and to make all laws and regulations for the proper distribution of the same, subject to the restrictions prescribed by this act: *Provided*, That no expense shall devolve upon the United States in consequence of said distribution.

"SEC. 3. *And be it further enacted*, That the said corporations shall have authority by ordinance, act, or otherwise to establish a scale of annual rates for the supply and use of said water apportioned to different classes of buildings in said city according to their size, dimensions, assessed values, exposures to fires, uses for dwellings, stores, shops, stables, manufactories, or other purposes, number of occupants, or consumption of water, measured by meter or otherwise, and to modify, alter, amend, increase, or reduce such scale from time to time, and to extend it to other descriptions of buildings and establishments; to collect such rates or rents, when so fixed, in advance or otherwise, through such agents or commissioners as they may authorize, from the owners or occupants of all such buildings or establishments respectively who may use the water therein; to stop the supply of water to any such dwelling or establishment upon a failure to pay said rate, charge, or rent; and generally to enact such laws as may be necessary to supply the inhabitants of said city of Washington with pure and wholesome water, and to carry into full and complete effect the powers herein granted: *Provided*, That the rates levied by the cities of Georgetown and Washington shall never be a source of revenue other than a means of keeping up to the said cities a supply of water.

"SEC. 4. *And be it further enacted*, That for the purpose of enabling the corporations aforesaid to carry out the provisions of this act it shall be competent for them to borrow in such proportions as they may deem expedient a sum of money not exceeding one hundred and fifty thousand dollars for the city of Washington, and fifty thousand dollars for Georgetown, redeemable within a period of ten years out of any revenue to be derived from water rents.

"SEC. 5. *And be it further enacted*, That it shall not be lawful for any person or persons other than said corporations or persons authorized by them to tap or open the mains or pipes laid or to be laid by the United States for any purpose whatever, under a penalty of not less than fifty nor more than five hundred dollars for each and every offense. And if any person or persons shall willfully and maliciously break, injure, deface, or destroy any main or pipe, bend, branch, valve, hydrant, service-pipe, or any other fixture used for the distribution of water throughout the streets and avenues, or for its introduction into the houses, tenements, or buildings of said cities, such person or persons shall be subject to imprisonment in the county jail for a period not exceeding two years for each and every such offense.

"SEC. 6. *And be it further enacted*, That whenever it shall become necessary to lay main pipes for the supply of water to the cities of Georgetown and Washington, the cost of the same shall be paid by said cities; and the engineer aforesaid is hereby prohibited from making any contracts for the same unless approved by the corporations aforesaid, and expressly stipulated with the contractor or contractors that the payment for the same is to be made by the said corporations: *Provided*, That no greater number of main pipes be laid by the General Government than are sufficient to give to said Government the necessary supply of water.

"SEC. 7. *And be it further enacted*, That it shall be unlawful for any person or persons to do or commit any act by reason of which the supply of water or any part thereof shall become impure, filthy, or in any way unfit for use; and that any person or persons committing any such act or acts willfully, knowingly, and maliciously, shall be subject to a fine of not exceeding one thousand nor less than five hundred dollars, or not exceeding three nor less than one year's confinement in the penitentiary of the District of Columbia for every such offense.

"SEC. 8. *And be it further enacted*, That all acts or parts of acts inconsistent with this act be, and the same are hereby, repealed.

"SEC. 9. *And be it further enacted*, That the cities of Washington and Georgetown respectively shall have power to establish a complete system of sewerage in aid of the execution of the provisions of this act.

"Approved March 3, 1859."

The tenth enactment is found on page 106, volume 12, Statutes at Large, in the appropriation bill for sundry civil expenses, approved June 25, 1860, which reads as follows:

For the completion of the Washington Aqueduct, four hundred thousand dollars, to be expended according to the plans and estimates of Captain Meigs, and under his superintendence: *Provided*, That the office of engineer of the Potomac water-works is hereby abolished, and the duties shall hereafter be discharged by the chief engineer of the Washington Aqueduct."

The eleventh enactment is found on pages 405, 406, and 407, volume 12, Statutes at Large, and reads as follows:

"An act to authorize the Corporation of Georgetown, in the District of Columbia, to lay and collect a water-tax, and for other purposes.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the mayor, recorder, aldermen, and common council of Georgetown, in the District of Columbia, shall have full power and authority to levy and collect a tax, not exceeding sixty cents per front foot on all lots and parts of lots within said corporate limits, in front of or parallel to which water mains have been or may hereafter be laid; or, in their discretion, to appropriate from the corporate funds generally so much money as may be necessary to supply the inhabitants of said town with Potomac water from the aqueduct mains or pipes now laid or to be laid in the streets of said town by the United States; and to make all laws and regulations for the proper distribution of the same, subject to the restrictions prescribed by this act, and the act approved March the third, eighteen hundred and fifty-nine, and entitled 'An act to provide for the care and preservation of the works constructed by the United States for bringing the Potomac water into the cities of Washington and Georgetown, for the supply of said water for all Government purposes, and for the uses and benefit of the inhabitants of said cities.'

"SEC. 2. *And be it further enacted*, That said corporation shall have full power and authority to collect such taxes, when so fixed, in advance or otherwise, through such agents, collectors, or commissioners as they may designate and appoint; and upon the failure of any owner of said lot or lots, or part thereof, to pay said taxes, to sell the same; or to stop the supply of water to the same, or to distrain and sell the personal effect of such owner, and in the case of any sale the same proceedings shall be observed as are adopted in enforcing the collection of the general tax of said town; and generally to enact such laws as may be necessary to furnish the inhabitants of said town with pure and wholesome water, and to carry into complete effect the powers herein granted: *Provided*, That the taxes levied by virtue of this act shall never be a source of revenue other than as a means of supplying said town with water.

"SEC. 3. *And be it further enacted*, That in levying said front foot tax, said corporation shall, in all cases where a lot or lots, or part thereof, may be situated at the intersection of two streets and fronting on the same, so reduce and graduate the tax thereon as not to exceed in all a tax upon one hundred feet front; and shall, in all cases where said property may have a front on any one or more steets, of more than one hundred feet, so reduce and graduate the tax thereon as not to exceed a tax upon one hundred feet front.

"SEC. 4. *And be it further enacted*, That all ordinances and resolutions, or parts thereof, relating to the distribution of Potomac water through said town, and the collection of a water-tax, and the ordinances and resolutions heretofore passed by said corporation particularly mentioned in this section, be, and the same are hereby, ratified and confirmed, said ordinances and resolutions being described and identified as follows, to wit: A resolution approved April the twenty-third, eighteen hundred and fifty-nine, entitled 'A resolution authorizing the tapping of water-mains;' a resolution, approved May the seventh, eighteen hundred and fifty-nine, entitled 'A resolution authorizing the laying of a water-main up High street;' an ordinance approved May the ninth, eighteen hundred and fifty-nine, entitled 'An ordinance authorizing the distribution of the Potomac water through the city of Georgetown;' a resolution approved May the fourteenth, eighteen hundred and fifty-nine, entitled 'A resolution repealing a part of a resolution for laying a water-main up High street;' an ordinance approved July the second, eighteen hundred and fifty-nine, entitled 'A supplement to an ordinance authorizing the distribution of the Potomac water through the city of Georgetown, approved May the ninth, eighteen hundred and fifty-nine;' a resolution approved July the second, eighteen hundred and fifty-nine, entitled 'A resolution approving of certain contracts for distributing water through the town;' a resolution approved August the twentieth, eighteen hundred and fifty-nine, entitled 'A resolution in relation to the water distribution;' a resolution approved September the seventeenth, eighteen hundred and fifty-nine, entitled 'A resolution authorizing the water board to purchase water-pipes;' a resolution approved September the seventeenth, eighteen hundred and fifty-nine, entitled 'A resolution in relation to water distribution;' a resolution approved September the twenty-fourth, eighteen hundred and fifty-nine, entitled 'A resolution supplementary to a resolution, entitled "A resolution in relation to the water distribution, approved August the twentieth, eighteen hundred and fifty-nine;" a resolution approved September the twenty-fourth, eighteen hundred and fifty-nine, entitled 'A resolution in relation to the redemption of water stock;' a resolution approved October twenty-nine, eighteen hundred and fity-nine, entitled 'A resolution in relation to water-mains;' a resolution approved November the fifth, eighteen hundred and fifty-nine, entitled 'A resolution approving the contract for patent water-pipes for Road street;' a resolution approved November the nineteenth, eighteen hundred and fifty-nine, entitled 'A resolution repealing a portion of the resolution approved April the twenty-third, eighteen hundred and fifty-nine, in relation to tapping water-mains.'

"SEC. 5. *And be it further enacted*, That in case of a failure to pay any taxes whatever laid by said corporation by virtue of its vested powers, it shall be lawful to sell, in the discretion of the collector or other proper officer, either the real or personal estate, or both, of the delinquent tax-payer; and so much of the eighth section of the act approved May the twenty-sixth, eighteen hundred and twenty-four, entitled 'An act supplementary to the act "to incorporate the inhabitants of the city of Washington," passed the fifteenth of May, one thousand eight hundred and twenty, and for other purposes,' as is in the following words, viz: '*Provided*, That no sale of real estate shall be made but where the owner or tenant of the property has not sufficient personal estate out of which to enforce a collection of the debt due,' be, and the same is hereby, repealed.

"SEC. 6. *And be it further enacted*, That the person or persons appointed to collect any taxes imposed by said corporation in pursuance of its vested powers shall have authority to collect the same by distress and sale of the goods and chattels of the person chargeable therewith, but no such sale shall be made unless ten days' previous notice thereof be given in some newspaper printed in the District of Columbia, aforesaid; and the provisions of the acts of Maryland now in force within said District relating to the right of replevying personal property taken in execution for public taxes shall apply to all cases of personal property taken by distress to satisfy taxes imposed by virtue of the corporate powers aforesaid.

"SEC. 7. *And be it further enacted*, That said corporation shall have power and authority to repair any of the footways of the streets in said town, and to impose and collect such tax or taxes on the lot or lots, or parts thereof, adjoining the same, as may be necessary to pay the expense of such repairs.

"SEC. 8. *And be it further enacted*, That so much of the first section of the act approved May thirty-one, eighteen hundred and thirty, entitled 'An act to amend the charter of Georgetown,' as is in the following words, viz: '*Provided*, That nothing in this act shall change the manner of giving notice of the sales of property owned by persons not residing in the District of Columbia,' be, and the same is hereby, repealed.

"Approved May 21, 1862."

The twelfth enactment is found on page 620, volume 12, Statutes at Large, and reads as follows:

"JOINT RESOLUTION transferring [the] supervision of [the] Potomac water-works to the Department of the Interior.

"*Resolved by the Senate and House of Representatives of the United States of America in Congress assembled*, That the supervision of the Potomac water-works be, and the same is hereby, transferred from the War Department to the Department of the Interior. And all unexpended money which has been heretofore appropriated, and all money which may be hereafter appropriated, for the completion of said water-works, shall be expended under the direction and supervision of the Secretary of the Interior.

"Approved June 18, 1862."

The thirteenth enactment is found on pages 804 and 805, volume 12, Statutes at Large, and reads as follows:

"AN ACT amendatory of an act entitled 'An act to provide for the care and preservation of the works constructed by the United States for bringing the Potomac water into the cities of Washington and Georgetown, for the supply of said water for all Gover[n]mental purposes, and for the uses and benefit of the inhabitants of the said cities.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That, in addition to the powers conferred upon the corporation of Washington by the second and third sections of the act of Congress approved March three, eighteen hundred and fifty-nine, [entitled] 'An act to provide for the care and preservation of the works constructed by the United States for bringing the

Potomac water into the cities of Washington and Georgetown, for the supply of said water for all governmental purposes, and for the uses and benefit of the inhabitants of the said cities,' full power and authority are hereby given to the said corporation to levy and collect a water-tax on all real property within the corporate limits of the city of Washington which binds on or touches on any avenue, street, or alley in which a main water-pipe has been laid or hereafter may be laid by the United States or by the corporation of Washington, which water-tax shall be as nearly as possible equal and uniform; may be levied on lots in proportion to their frontage or their area, as the said corporation may determine; and may be collected in not less than three nor more than five annual installments, of which installments all after the first shall bear interest at the rate of six per centum per annum, commencing from the date *of* [at] which the first installment becomes due, but may, at the option of the owner of the property taxed, be paid and discharged in full at any time after it shall have been levied. And the said corporation of Washington is further authorized and empowered, on petition of the owners of the majority of the real estate on any square or line of squares, to lay down water-pipes and erect fire-plugs and public hydrants wherever the same may be requisite and necessary for public convenience, security from fire, or for health.

"SEC. 2. *And be it further enacted*, That, to aid in the erection, maintenance, and efficiency of fire-plugs throughout the city, the said corporation of Washington is hereby authorized and empowered to levy and collect a special annual tax on all buildings within five hundred feet of any main water-pipe into which, or the premises connected therewith, the water has not been introduced, and the owners or occupants of which do not pay an annual water-rate or rent in accordance with the ordinances of the corporation, which tax shall be levied with reference to the value of the building so taxed, and shall be not more than five dollars nor less than one dollar per year; but whenever the water shall be introduced, in conformity with the corporation laws, into any building or premises, the fire-plug tax thereon shall cease; and whenever the water shall be discontinued from any building or premises into which it has been introduced, the said building shall be subject to the fire-plug tax from the date of the discontinuance of the water.

"SEC. 3. *And be it further enacted*, That the water-tax hereby authorized to be levied and collected shall constitute a fund to be used exclusively to defray the cost of distribution of the water, including all necessary fixtures and machines connected with said distribution; and the annual water rates or rents authorized to be collected by the act of which this act is amendatory shall constitute a fund exclusively for the maintenance, management, and repair of the system of water distribution.

"Approved March 3, 1863."

The fourteenth enactment is found on page 384, volume 13, Statutes at Large, and reads as follows:

"AN ACT to provide for the supervision, repairs, liabilities, and completion of the Washington Aqueduct.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That the sum of one hundred and fifty thousand dollars be, and the same is hereby, appropriated out of any money in the Treasury not otherwise appropriated, for the purpose of constructing the dam of solid masonry across the Maryland branch of the Potomac River, near the Great Falls, and for constructing the conduit around the receiving *resaroir*, [reservoir,] and for paying existing liabilities and expenses, engineering, superintendence, and repairs of said aqueduct.

"Approved July 4, 1864."

The fifteenth enactment is found on pages 133 and 134, volume 13, Statutes at Large, and reads as follows

"AN ACT to amend an act entitled 'An act to authorize the corporation of Georgetown, in the District of Columbia, to lay and collect a water-tax, and for other purposes,' approved May twenty-one, eighteen hundred and sixty-two.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That in all cases in which an original town lot in Georgetown, in the District of Columbia, entirely owned by the same person or persons, or any subdivision of an original lot separately owned, as aforesaid, shall be situated at the intersection of two streets, so as to bind or front on both, and in which both fronts would be liable to the front-foot tax authorized by the act entitled 'An act to authorize the corporation of Georgetown, in the District of Columbia, to lay and collect a water-tax, and for other purposes,' approved May twenty-one, eighteen hundred and sixty-two, the said front-foot tax shall not be levied upon more than seventy-five feet of the two fronts of said lot or part of lot; and all beyond said number of feet shall be exempt therefrom: *Provided*, That, for the purpose of avoiding inequality and hardship in laying said tax, it shall be lawful for the said corporation of Georgetown, in such cases, to make such further exemptions from said front-foot tax, either by general laws or in individual cases, as to them may seem just and proper.

"SEC. 2. *And be it further enacted*, That it shall be lawful for said corporation of Georgetown, in their discretion, instead of the front-foot tax aforesaid, to lay and collect annually a general special tax not to exceed one-fifth of one per cent. per annum on all the assessable property in said town, for the purpose of defraying the cost of distributing water through said town from the mains or pipes of the Washington Aqueduct, which tax shall be exclusively appropriated to said object, shall be collected in the same manner as the general tax of said town, and shall cease whenever the cost of said distribution shall have been fully paid: *Provided*, That all persons liable to pay said tax shall be credited on account of the same with all sums heretofore paid by them on account of said front-foot tax, levied in pursuance of the act to which this is an amendment.

"SEC. 3. *And be it further enacted*, That the third section of the act aforesaid be, and the same is hereby, repealed.

"Approved June 17, 1864."

The sixteenth enactment is found on page 316, volume 14, Statutes at Large, in the appropriation bill for sundry civil expenses, approved July 28, 1866, which reads as follows:

"To complete the dam in the Potomac River at the head of the aqueduct, from the shore to Conn's Island, with cut stone, fifty-one thousand six hundred and eighty-seven dollars.

"To complete the connecting conduit around and outside the receiving reservoir, seventy thousand eight hundred and ninety-seven dollars.

"To finish gate-house at Great Falls, four thousand dollars.

"For temporary dam at Conn's Island, one thousand dollars.

"For embankments, miscellaneous, and contingents, fifteen thousand dollars."

The seventeenth enactment is found on page 374, volume 14, Statutes at Large, in the deficiency appropriation bill:

"For repairing the damage done to the Washington Aqueduct by freshets in the year eighteen hundred and sixty-six, twelve thousand dollars.

"Approved December 20, 1866."

The eighteenth enactment is found on page 464, volume 14, Statutes at Large, and is contained in the appropriation bill for sundry civil expenses, approved March 2, 1867, which reads as follows:

"For the payment of the employés in the management, engineering, and repairs of the Washington Aqueduct, twenty thousand dollars."

The nineteenth enactment is found on page 466, volume 14, Statutes at Large, in an act making appropriation for sundry civil expenses, approved March 2, 1867, and reads as follows:

"SEC. 2. *And be it further enacted*, That the office of Commissioner of Public Buildings is hereby abolished; and the Chief Engineer of the Army shall perform all the duties now required by law of said Commissioner, and shall also have the superintendence of the Washington Aqueduct and all the public works and improvements of the Government of the United States in the District of Columbia, unless otherwise provided by law; and the Sergeant-at-Arms of the Senate and the Sergeant-at-Arms of the House of Representatives shall hereafter appoint the members of the Capitol police."

The twentieth enactment is found on page 464, volume 14, Statutes at Large, and is contained in an act entitled "An act to authorize the appointment of certain watchmen, and for other purposes," approved March 30, 1867, and reads as follows:

"SEC. 3. *And be it further enacted*, That all moneys appropriated for the Washington Aqueduct, and for the other public works of the District of Columbia, shall be expended under the direction of the Secretary of War."

The twenty-first enactment is found on page 118, volume 15, Statutes at Large, in the general appropriation bill, approved February 20, 1868, which reads as follows:

"For continuing the United States 20-inch water-main from its present terminus in North B street, on the east side of Delaware avenue, to the United States 12-inch main on First street east, ten thousand dollars."

The twenty-second enactment is found on page 174, volume 14, and is contained in an appropriation act to supply deficiencies for the year ending June 30, 1868, and reads as follows:

"To meet a deficiency in the cost of completing certain portions of the Washington Aqueduct, comprising the Potomac dam, repairs of temporary dam, gate-house at Great Falls, and the connecting conduit at the receiving reservoir, twenty-seven thousand dollars: *Provided*, That the sum shall be in full for all claims against the Government for work done or damages incurred on the Washington Aqueduct.

"For salary of assistant engineer, superintendence, and repairs for the year ending June 30, 1869, twenty-five thousand dollars, to be expended under the immediate direction of the officer detailed to act as superintendent of public buildings and grounds."

The twenty-third enactment is contained in the appropriation bill for sundry civil expenses, approved March 3, 1869, on page 309, volume 14, and reads as follows:

"For repairs and superintendence of the Washington Aqueduct, twenty-five thousand dollars."

The twenty-fourth enactment is found on page 276, volume 16, Statutes at Large, and is entitled—

"AN ACT authorizing the establishment of water-meters for the Potomac water, the laying of an additional water-main from the distributing reservoir of the Washington Aqueduct, and for other purposes.

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That in order to prevent unnecessary waste of Potomac water, and in order to more fully enforce the laws of the corporation of Washington and Georgetown in relation to the distribution of the same, the engineer officer in charge of the Washington Aqueduct is hereby authorized and empowered, after giving notice, to shut off the water, when such notice shall be disregarded, from any places where a waste of water is occurring.

"SEC. 2. *And be it further enacted*, That the use of Potomac water for mechanical and manufacturing purposes, or for private fountains, street and pavement washers, shall be allowed only when, in the opinion of said engineer, it will not be detrimental to the general distribution of water in the two cities.

"SEC. 3. *And be it further enacted*, That the supply of water to all manufacturing establishments, hotels, livery stables, and other places requiring a large quantity, shall be determined by meters erected and maintained at the expense of the consumer; and the said corporations of Washington and Georgetown shall charge and collect for the quantity so determined a price not exceeding three cents per hundred gallons.

"SEC. 4. *And be it further enacted*, That said engineer officer shall cause to be furnished and laid from the distributing reservoir of the Washington Aqueduct to Capitol Hill, in the city of Washington, along such route as he shall determine, an iron main of thirty-six inches in diameter, connected with the present mains at such points as he shall direct, and that the entire cost thereof shall be borne proportionately by the corporations of Washington and Georgetown; and in order to provide for such cost the said corporations are hereby empowered and authorized to increase the present water-rates and water-taxes to such an amount as may by them be deemed necessary.

"SEC. 5. *And be it further enacted*, That for the purpose of enabling the corporations aforesaid to carry out the provisions of this act, it shall be competent for them to borrow, in such proportions as they may deem necessary, a sum of money not exceeding two hundred and sixty thousand dollars for the city of Washington, and forty thousand dollars for the city of Georgetown, redeemable within a period of ten years, out of any revenue to be derived from water-rents.

"Approved July 14, 1870."

The twenty-fifth enactment is found on pages 301, 302, volume 16, in the bill making appropriations for sundry civil expenses of the Government for the year ending June 30, 1871, approved July 15, 1870, which reads as follows:

"For the completion of the Washington Aqueduct, except coping and covering of bridges; for rent and purchase of five and forty-four one-hundredths acres of land, one thousand three hundred and twenty dollars.

"For purchase of roadway from Great Falls to conduit road, two and three-tenths miles, eighteen and four-tenths acres, one thousand and twelve dollars.

"For purchase of roadway across land owned by Wm. Brooke, five hundred and fifty dollars.

"For rent and purchase of land at high-service reservoir, in Georgetown, three thousand three hundred dollars.

"For rent and purchase of land at bridge number six, in Georgetown, two thousand six hundred and forty dollars.

"For clearing out obstructions near the dam, to give free access in low water to the head of the aqueduct, five thousand five hundred dollars.

"For repairs in tunnel number one, and removing fallen stones, one thousand five hundred dollars.

"For preserving the new or Dalecarlia tunnel from falling in, and protecting bank of connecting conduit, twenty thousand dollars.

"For completing the distributing reservoir according to the original plan: First, slope-wall for protection of banks, thirty thousand dollars; second, repairing earthen banks, and completing dividing bank, and setting iron valve gate therein, five thousand dollars; third, completing the two gate-houses of this reservoir, twenty thousand dollars.

"For arrears of superintendence and repairs to July first, eighteen hundred and seventy, four thousand dollars.

"For completing work at arch over high-service reservoir and placing rail round the same, four thousand dollars.

"For superintendence and general repairs, twelve thousand dollars.

"For macadamizing the top of the conduit now used as the main road to Washington, ten thousand dollars; in all, one hundred and twenty thousand nine hundred and thirty-two dollars: *Provided*, That the money hereby appropriated for the Washington Aqueduct shall be applied to the objects named herein, and to no others: *Provided further*, That all water-rents derived from the Washington Aqueduct shall be applied to the improvement and repair of the same, and for no other purpose, until otherwise provided by law."

The twenty-sixth enactment is found on page 505, volume 16, Statutes at Large, in the general appropriation bill, approved March 3, 1871, which reads as follows:

"For finishing coping and iron railing on bridges numbers one, two, three, and four, ten thousand dollars.

"For widening embankments over conduit, and macadamizing roads, ten thousand dollars.

"For completing gate-houses at distributing reservoir, twenty thousand four hundred and ninety-six dollars.

"For completing high-service reservoir, four thousand dollars.

"For ventilators over conduit, two thousand eight hundred dollars.

"For fencing reservoirs, three thousand six hundred dollars.

"For building office at Rock Creek Bridge, three thousand three hundred dollars.

"For engineering, superintendence, and repairs for the fiscal year ending June thirty, eighteen hundred and seventy-two, twenty thousand dollars.

"For completing earth-work and making the slope-wall of division dam, twenty thousand dollars.

"For completing slope-wall of distributing reservoir, twenty thousand dollars."

AN ACT OF THE LEGISLATURE OF THE DISTRICT OF COLUMBIA.

AN ACT to provide for additional supply of Potomac water by means of the Washington Aqueduct to the cities of Washington and Georgetown, and authorizing a loan for said purpose.

Be it enacted by the Legislative Assembly of the District of Columbia, That the governor be, and hereby is, authorized and instructed, immediately after the passage of this act, to adopt measures for speedily complying with the injunctions of the fourth and fifth sections of the act of Congress of July fourteen, eighteen hundred and seventy, directing the engineer of the Washington Aqueduct to afford to the cities of Washington and Georgetown an additional supply of Potomac water, by the laying of a new iron main of thirty-six inches in diameter, at the expense of the cities aforesaid, from the distributing reservoir above Georgetown to Capitol Hill, the said new main to be judiciously connected with the water-mains already laid at such points as are hereinafter designated.

SEC. 2. *And be it further enacted*, That in order to provide measures to defray the expense of complying with the aforesaid act of Congress, the governor be, and is hereby, authorized and empowered, in behalf of the government of the District of Columbia, to issue, or cause to be issued, registered or coupon bonds, designated on their faces as "water stock," to an amount not exceeding four hundred and fifty thousand dollars, in denominations of one hundred, five hundred, and one thousand dollars, payable in thirty years from the date of their issue; the said bonds to bear interest not exceeding seven per centum, payable on the first days of January and July in each and every year, in current money of the United States; for the punctual payment of which interest, and for the redemption of the said bonds in the manner provided for in the sixth section of this act, the faith of the government of the District of Columbia is hereby solemnly pledged.

SEC. 3. *And be it further enacted*, That the bonds issued in pursuance of the foregoing section shall be signed by the governor and countersigned by the secretary of the District of Columbia, and attested by its seal; that all sales thereof shall be made by the governor, who shall deposit the money received therefor to the credit of the water fund, which money shall be held and applied exclusively to the objects of this act, and to no other purposes whatever.

SEC. 4. *And be it further enacted*, That the said bonds shall not be sold or exchanged for less than their par value, in current funds of the United [States,] unless such sale or exchanges shall have been previously authorized by an act of the legislative assembly of the District of Columbia, and when the said bonds shall have been signed and prepared for issue they shall be placed in the custody of the register of the city of Washington, or with the comptroller or auditor of the said city, or with such other officer as may hereafter be selected or appointed as chief of the financial affairs of the government; and the said officer to whom the care of said bonds may be intrusted shall not permit any one or more of them to go out of his possession, unless for the purpose and in accordance with the provisions of this act: *Provided*, That no greater quantity of said bonds shall be signed or prepared for issue than is required to supply the demands therefor: *And provided further*, That the officer in whose custody said bonds are placed, shall give such security for their safe-keeping as may be required by the governor.

SEC. 5. *And be it further enacted*, That the register or other officer to whose custody the said bonds may be committed, shall keep an accurate account of the number, denomination, amount, and date of all bonds issued or prepared for issue, and make full reports of the same from time to time to the legislative assembly, showing the amount of sales and the proceeds thereof, as well as the amount of interest that shall have accrued or been paid on account thereof.

SEC. 6. *And be it further enacted*, That there be, and is hereby, set apart, pledged, and appropriated out of the water fund, such sum as may be necessary to pay the interest on said bonds for the ensuing year, and for each succeeding year thereafter, until all the bonds shall have been redeemed, and that an amount of not less than fifteen thousand dollars shall be set apart annually for the payment of said bonds, by their gradual redemption, which money shall be applied each and every year to their purchase in open market, or by means of public advertisement, as the governor may deem most advantageous for the public interest.

SEC. 7. *And be it further enacted*, That the legislative assembly shall, if necessary, increase the water rents so as to promptly pay out of the water fund the interest on said bonds as the same shall become due, and for the gradual redemption of the bonds.

SEC. 8. *And be it further enacted*, That any officer of this government, or any fiduciary agent or employé thereof, who shall appropriate or apply, or in any manner consent to aid, or assist in appropriating or applying, by the drawing, signing, or payment of any check, warrant, or otherwise, any portions of any money provided for the redemption of the bonds aforesaid, or for the payment of the interest thereon, or who shall direct or use any money belonging to the water fund, for any other purposes than those for which the fund shall have been created, shall be deemed guilty of a misdemeanor, and on conviction thereof, before a court of competent jurisdiction, shall be subject to a penalty of not less than five hundred nor more than one thousand dollars, and imprisonment for a term of not less than three nor more than twelve months.

SEC. 9. *And be it further enacted*, That the United States engineer in charge of the Washington Aqueduct be, and is hereby, authorized and empowered, in conjunction with the governor of the District of Columbia, to enter into contract for the laying of the 36-inch cast-iron main mentioned in the first section of this act, and to adopt the following route for the same, namely: From the distributing reservoir to Bridge street, in Georgetown, and along the said street to the aqueduct bridge over Rock Creek, connecting at said bridge with one of the 48-inch pipes in which the water is conducted over Rock Creek, and continuing eastwardly from the east side of said creek, along Pennsylvania avenue to its junction with L street north, and thence along L street to its junction with New Jersey avenue; from that point it shall be extended by a 36-inch branch and 30-inch main, running along New Jersey avenue to its junction with Massachusetts avenue, and there connected with the 30-inch supply-main already laid.

SEC. 10. *And be it further enacted*, That at such intersections of streets or avenues, and along the lines of the new main hereby authorized, as the engineer may deem necessary, there shall be branches with outlets of such diameter as may be prescribed by him, and the number of 36-inch stop-valves shall not be less than six between the connection of the new main with the distributing reservoir and 36-inch branch at New Jersey avenue.

SEC. 11. *And be it further enacted*, That in order to afford a full supply of water to those sections of the city of Washington known as Capitol Hill and the Navy-Yard, the 20-inch cast-iron main now terminating at the intersection of First street east and B street north, shall be continued along B street north to Eleventh street east, with such branches and connections and stop-valves at all intersections of streets and avenues as may be deemed best by the engineer in charge of the Washington Aqueduct.

SEC. 12. *And be it further enacted*, That the engineer aforesaid be, and he is hereby, authorized and requested to invite proposals by circulars and newspaper publications, from manufacturers of iron pipes in New York, Philadelphia, Baltimore, Pittsburgh and Washington, for supplying the pipe, branches, and stop-valves necessary for the new mains herein authorized, and also to invite proposals by public advertisements in at least two newspapers in the city of Washington; for the hauling, excavation, and other work necessary to complete the laying of the said mains, and that the contracts for supplying the said pipe and the laying thereof shall, in all cases, be given to the lowest responsible bidders, upon the execution and delivery by them of good and sufficient bonds with surety, to an amount of at least twenty per centum of the contract, for the prompt and faithful performance of all of its obligations; and no money shall be paid on account of any contract for materials or work herein authorized, except upon the approval and order of the engineer of the Washington Aqueduct.

SEC. 13. *And be it further enacted*, That in order to defray the expense of laying the said mains, with the necessary branches and stop valves, as provided by this act, the sum of four hundred and fifty thousand dollars, or so much thereof as may be necessary, be, and the same is hereby, appropriated, payable out of the water fund, to be raised by the bonds and water rents aforesaid: *Provided*, That for the performance of the duties imposed by this act, or any duty connected therewith, no compensation shall be paid or allowed to any officer of the government in excess of that which he may receive at the time of the passage of this act.

SEC. 14. *And be it further enacted*, That the present inadequate supply of water renders the passage of this act a case of emergency, and therefore this act shall go into effect from and after the date of its approval.

Approved July 20, 1871.

X 2.

OFFICE OF PUBLIC BUILDINGS, GROUNDS, AND WORKS,
October 19, 1871.

SIR: I have the honor to inform you that in accordance with Special Order No. 196 from the War Department, Adjutant General's Office, Washington, dated May 18, 1871, on June 1, 1871, I relieved from duty Major N. Michler, in charge of public buildings, grounds, and works. Major Michler turned over to me the balance of the money remaining in his hands unexpended, amounting in the aggregate to $14,006 40, and there was also remaining in the Treasury a balance of appropriations of $6,272, which was drawn out upon my own requisition.

The public property was received and receipted for by me on June 8, 1871. Being the last month of the fiscal year, and the funds at my disposal being generally small balances of different appropriations, nothing was done more than the proper care and protection of the different reservations, for which purpose a portion of the funds turned over to me was expended. The balance in such cases, as the nature of the appropriation would admit, was expended in the purchase of material. The amount remaining of the appropriation for the opening and improvement of Executive avenue was expended upon that work, and in the purchase of stone for the sidewalks, &c.

On taking possession of the office I appointed Mr. George D. Benjamin as my assistant, from whom I have received very efficient service.

The grounds south of the Executive Mansion were partially graded and filled preparatory to sowing with grass-seed. Lamp-posts were purchased and placed around Scott Square, the circle at the intersection of Vermont and Massachusetts avenues, along Missouri avenue between Eighth and Ninth streets, and around Executive avenue as far as the work has been completed. The small triangular reservation, corner of Pennsylvania avenue and Seventh street, was laid out in walks and opened for the benefit of ladies and children who might wait at that point for the street-cars.

An unexpended balance of $120 51 remained on the 30th of June, 1871, which amount is to be recovered back into the Treasury.

Upon assuming charge of the public buildings and grounds, no state-

Since the transmission by Major Michler
claims, additional claims, amounting to the su
by him, have been filed in the office by the cred
an amount of outstanding indebtedness, exp
amounts appropriated by Congress, of $51,824
fully recommend an appropriation to meet thi
part of this amount is for work and material
avenue during the year 1869.

At the time the appropriations for the prese
the improvement of Pennsylvania avenue and
of the Treasury, had just been completed. Th
to be borne by the Government for the paving
property was provided for in the appropriatio
year, and has been settled.

The important improvement known as the E
the south and west sides of the Executive Man
through the President's grounds to Pennsylv
adopted for this improvement proposes to com
west side in a corresponding manner with the
rially enhance the beauty of the grounds, as we
ful drive. The amount asked for is believed to
the avenue.

The grounds south of the Executive avenue, a
Lot," and the grounds surrounding the unfinis
ment, should be graded and connected by a bri

The grounds west of the Botanical Garde
grounds should also be improved. These rese
the Smithsonian and Agricultural grounds, wo
line of improved reservations from the Executi
tol of over a mile in length, through which bea

to continue its embellishments. The portion of the city in the vicinity of this park is being rapidly improved.

The experience of the Agricultural Department, as well as the loss of the grass in several of the parks during the last summer, have demonstrated that it is necessary to have a free and unlimited supply of water, in order to keep the grass alive and retain a fresh appearance. No provision has been made for water in many of the squares and parks. It has already been introduced in Lafayette Square, and it is proposed to introduce it in Franklin Square and the other grounds, where it can be used to advantage. In the larger parks it is intended to introduce gas, as well as water, and part of the appropriation asked for is to be used for that purpose.

An appropriation is also asked for the introduction of an additional number of German sparrows in the parks, and the erection of suitable boxes and nests for their care and protection. Their introduction in other cities has proved of great value in destroying many of the worms and insects peculiarly destructive to the trees and shrubs.

The organic act creating the territorial government of the District placed the streets, avenues, and alleys of the city under the charge of the Board of Public Works; no appropriation is, therefore, asked for their care or improvement. The custody of the various bridges heretofore in charge of the Superintendent of Public Buildings and Grounds is also assigned to the Board of Public Works, with the exception of Long Bridge, which has been transferred to the Baltimore and Potomac Railroad Company, and is now being rebuilt.

Benning's Bridge is in good condition and repair. The Navy-yard Bridge has been kept in as good repair as possible, considering the nature of the material of which it is constructed, much of the timber being old and partially decayed.

The sum of $2,000 was placed in my hands by the territorial government of the District, to be expended upon the Chain Bridge. Two spans of the bridge, on the Virginia side, were left standing at the time of the destruction of the bridge by the freshet. These spans were thrown from their proper place on the piers and the arches bent considerably from their vertical position. With the assistance of hydraulic screws and other instruments, furnished by the Navy Department, these two spans were raised again and rendered safe for crossing. The inclined approach to the bridge may be swept away at any time by high water. Should this occur, there is sufficient amount of funds unexpended, together with the old timber remaining, to reconstruct the approach.

The improvement of various avenues provided for in the appropriations for the present fiscal year has been delayed, in many instances, in order that the permanent grade of those avenues may be established by the Board of Public Works. Maine avenue, along the line of the Government reservation, has been improved by curbing, construction of gutter, and new brick sidewalk. I would respectfully call attention to the estimates for reservations on the various avenues. The citizens of the Territory, through the Board of Public Works, are making such valuable improvements in every direction, and taking such liberal and energetic action in beautifying the city, that their efforts should be seconded as much as possible by inclosing such small triangular and circular reservations as come within the line of the city improvements, thus making green and beautiful what are now, in most cases, open places of sand and mud.

The sum of $2,000 asked for starting a nursery is intended to be used for that purpose on some one of the Government reservations in the city.

This is something that is needed, and the want of which has been felt heretofore, as but very few varieties, and of the commonest kind, can be purchased in this vicinity, and, for the better varieties, it has been necessary to send to some other point. The trees so purchased, in a great many instances, have died, owing to size of trees, change of climate, soil, &c., &c. If they could have been brought here when young and transplanted, no doubt the greater part would have lived. A few thousand dollars appropriated annually for the purchase of young trees and shrubs would, after a few years, give the Government a large and useful nursery of its own. A great many trees and shrubs could be raised from the seed, which would be a great saving to the Government in time and money, as most of the newer varieties have to be imported at great expense.

An appropriation is respectfully recommended for the purpose of procuring oil paintings of nine ex-Presidents, to complete the collection now in the Executive Mansion.

Attention is also called to the memorial from citizens herewith attached, asking the purchase of two triangular pieces of ground on New Jersey avenue and I street, and for the improvement of the same. The amount estimated to be necessary for the purpose is $20,000, and I earnestly recommend that that sum be appropriated.

Accompanying this report is a detailed estimate for funds required for the next fiscal year.

Very truly, yours,

O. E. BABCOCK,
Major of Engineers, U. S. A., in Charge.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Washington, D. C.

General O. E. BABCOCK,
Superintendent Public Buildings, &c.

SIR: Some years ago (during the latter part of Mr. Johnson's administration) a memorial headed by General Grant, then residing in I street, and numerously signed by property owners in that vicinity, was addressed to Congress through Hon. B. B. French, then Commissioner of Public Buildings and Grounds, representing the earnest desire of the petitioners to have the United States Government repossess itself of the two triangular spaces, one formed by the intersection of First street west, H street north, and New Jersey avenue, and the other by the intersection of New Jersey avenue, H street north, and Second street west

The reasons set forth in the memorial referred to were the nuisance likely to be created by the erection of shanties and cheap buildings thereon by the owners, to the detriment of the respectable property interest in the neighborhood; and the great want of some breathing place or open space in the locality referred to for a large surrounding population, which is daily augmenting in density.

The reservations referred to were formerly the property of the United States, and were sold by a former Commissioner of Public Buildings, by order of Congress, for the purpose of raising funds to beautify and improve similar spaces along Pennsylvania avenue.

The memorial referred to is probably on file in your office. Mr. French in his last report to Congress warmly recommended the repurchase of these reservations by the Government for the purposes set forth in the memorial, and General Michler, his successor, twice recommended their repurchase in his report to Congress.

The object of this communication is to call your attention to the facts, and respectfully to entreat you to urge upon Congress at its next session the importance of repurchasing and improving the reservations referred to, whereby the section of the city in which they are situated may be rendered more beautiful and attractive, the miserable unhealthy shanties removed, which now disfigure one of them, and the public health materially conserved.

Inclosed herewith please find sketch of the reservations above referred to, with outline of the surrounding streets and squares, according to the certified plat of the city, and as in duty bound the undersigned will ever pray.

William Stickney, *President Council.*

W. T. Sherman.
Robert M. Douglass.
Robert J. Stevens.
D. D. Cone.
Oscar Oldberg.
A. J. Schafhirt.
W. Flenner.
A. Talbert.
S. V. Noyes.
D. Connell.
N. Bauers.
T. Thompson.
L. G. Marini.
A. G. Mackey.
A. Luby.
F. A. Chase.
Daniel McLaughlin.
P. H. Cooney.
John Wise.
Peter Monaghan.
M. R. Woodward.
W. G. Phillips.

Estimate of appropriations required for the service of the fiscal year ending June 30, 1873, by Major O. E. Babcock, United States Engineers.

Detailed object of expenditure and explanations.	Date of act, &c., providing for the expenditure.	Reference to Statutes at Large.			Estimated amount which will be required for each detailed object of expenditure.	Amount appropriated for the current fiscal year ending June 30, 1872.
		Vol.	*Page.*	*Sec.*		
For contingents of office of Public Buildings	March 3, 1871	Pam.	504	1	$2,000	$2,000
For fuel for center building, Capitol	March 3, 1871	Pam.	504	1	1,500	1,500
For repairs, fuel, &c., Executive Mansion, 1873:						
Fuel	March 3, 1871	Pam.	504	1	5,000	3,000
Repairs to the mansion	March 3, 1871	Pam.	504	1	10,000	5,000
Refurnishing the same	March 3, 1871	Pam.	504	1	10,000	5,000
Repairs of, and care of Green-house at Executive Mansion, including new floor, flower-stands, pipes, &c	March 3, 1871	Pam.	504	1	10,000	3,000
Constructing 634 feet sewer to drain Executive Mansion	Submitted	......	......	......	3,000	....
Lighting, &c., Capitol, Executive Mansion, &c., 1873:						
Pay of lamp-lighters gas-fitting, plumbing, lamp, &c., posts, and repairs of all sorts	March 3, 1871	Pam.	504	1	15,000	10,000
Lighting Capitol, Executive Mansion, &c	March 3, 1871	Pam.	504	1	45,000	40,000
Lighting Lincoln Square	Submitted	......	......	......	500	....
Lighting grounds around Executive Mansion	Submitted	......	......	......	1,000	....
Lighting Lafayette Square	Submitted	......	......	......	1,000	....
Lighting Franklin Square	Submitted	......	......	......	1,000	....
Lamps and lamp-posts for center and south walk, west Capitol grounds	Submitted	......	......	......	500	....
For continuing work on Executive avenue, including coping, curbing, flagging, fencing, and macadamizing, &c	March 3, 1871	Pam.	505	1	40,000	45,500
Care and improvement, Reservation No. 2 and Lafayette Square, including the grading of the entire south side of Reservation No. 2, making walks and repairing drain as per plan.	March 3, 1871	Pam.	504	1	28,000	7,500
Annual repairs of fences around reservations	March 3, 1871	Pam.	504	1	2,000	2,000
For manure and hauling the same on public grounds	March 3, 1871	Pam.	504	1	5,000	3,000
Painting iron fences around reservations and around War and Navy Departments	March 3, 1871	Pam.	504	1	4,000	2,000
Improvement, care, and protection of seats in Capitol grounds	March 3, 1871	Pam.	504	1	3,000	2,000
Purchase of seats in Capitol grounds	Submitted				1,000	....
For repairs of carts in public grounds	March 3, 1870	Pam.	504	1	5,000	3,000
Hire and repair of tools in public grounds	March 3, 1871	Pam.	504	1	3,000	2,000
Purchase of trees, tree-boxes, white-washing fences, &c	March 3, 1871	Pam.	504	1	[illegible]	[illegible]
Purchase of flower pots, mats, twine, glasses, &c	March 3, 1871	Pam.	504	1	[illegible]	[illegible]
Care and improvement of grounds south of Executive Mansion, including purchase of trees and making walks, grading, &c	March [illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
[illegible] Green-house, propagating gardens	March [illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
[illegible] Franklin Square, introducing water, gas, [illegible] &c.	[illegible]	[illegible]	[illegible]	1	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

Improving and grading Armory Square, making and graveling walks, roads, purchase of trees and drainage, &c	Submitted				10, 000	
Grading, opening walks and roads, and graveling the same, drainage, purchase of trees and shrubs, for improvement of reservation between Third and Sixth streets, as per plan.	Submitted				20, 000	
Removing snow and ice from pavements and walks	March 3, 1871	Pam.	504	1	2, 000	1, 000
Grading "Stanton Place," making walks, building pavements and gutters, purchase of trees, and fencing the same	Submitted				10, 000	
Improving circle intersection of Vermont and Rhode Island avenues, by inclosing, building pavement, grading, opening walks, &c.	Submitted				5, 000	
Starting a nursery for improvement of public grounds	Submitted				2, 000	
Improving Lincoln Park, building pavements, opening walks, lodge, &c	Submitted				8, 500	
Improving reservation on New York avenue and Eighteenth street	Submitted				7, 500	
Continuing improvements in Farragut Square	Submitted				5, 000	
Rebronzing gas-fixtures in the Capitol	Submitted				3, 000	
Repairs of Government water-pipes and fire-plugs, and purchase of apparatus for cleaning water-pipes	March 3, 1871	Pam.	504	1	10, 000	5, 000
Purchase of sparrows, cages, boxes, and care of same	Submitted				500	
Purchase of tree-markers, and marking the same	Submitted				500	
For abating nuisances	Submitted				1, 000	
Improving reservations on different avenues	March 3, 1871	Pam.	504	1	25, 000	15, 000
For salaries of employés:						
Clerk in the Office of Public Buildings	March 3, 1871	Pam.	479	1	1, 200	1, 200
Messenger in the Office of Public Buildings	March 3, 1871	Pam.	479	1	840	840
Public gardener	March 3, 1871	Pam.	479	1	1, 440	1, 440
Foreman and twenty-one laborers	March 3, 1871	Pam.	479	1	19, 296	19, 296
Laborer in charge of water-closets in the Capitol	March 3, 1871	Pam.	479	1	720	720
Four laborers in the Capitol	March 3, 1871	Pam.	479	1	2, 880	2, 880
Furnace-keeper under old hall of House of Representatives	March 3, 1871	Pam.	479	1	864	864
Furnace-keeper at the President's House	March 3, 1871	Pam.	479	1	720	720
Two policemen at the President's House	March 3, 1871	Pam.	479	1	2, 640	2, 640
Two night watchmen at the President's House	March 3, 1871	Pam.	479	1	1, 800	1, 800
Door-keeper at the President's House	March 3, 1871	Pam.	479	1	1, 200	1, 200
Assistant door-keeper at the President's House	March 3, 1871	Pam.	479	1	720	720
Two draw-keepers at bridges, and fuel, oil and lamps	March 3, 1871	Pam.	479	1	1, 600	1, 600
Five watchmen in Reservation No. 2	March 3, 1871	Pam.	479	1	3, 600	3, 600
Watchman in Franklin Square	March 3, 1871	Pam.	479	1	720	720
Electrician to light Capitol dome	March 3, 1871	Pam.	479	1	1, 200	1, 200
Person to take charge of heating-apparatus, Library of Congress	March 3, 1871	Pam.	479	1	864	864
Watchman at Lafayette Square	Submitted				720	
Watchman at the circle, Pennsylvania avenue and Twenty-fourth street	Submitted				600	
Watchman at the circle, Massachusetts and Vermont avenues	Submitted				540	
Watchman at Lincoln Square	Submitted				540	
Total					416, 204	

X 3.

ENGINEER OFFICE,
HEADQUARTERS MILITARY DIVISION OF THE PACIFIC,
San Francisco, California, September 13, 1871.

GENERAL: The following report is respectfully submitted in relation to certain duties which have engaged my attention during the fiscal year ending the 30th of June, 1870; they consisted in having charge of the public buildings and grounds and certain public works in the District of Columbia, and in the execution of many other official acts. The latter principally consisted in serving upon various commissions and committees authorized by different laws of Congress, and which principally related to important improvements of the city; over these the General Government assumed no immediate control save to authorize by statutes the manner of executing them. In my last annual report reference was made to most of them.

RIVER CHANNEL IMPROVEMENTS.

This subject has been frequently discussed on previous occasions. An act of Congress, (Public No. 152,) approved July 11, 1870, making appropriations for the repairs, preservation, and completion of certain public works on rivers and harbors, and for other purposes, for the fiscal year ending June 30, 1871, contained a clause appropriating $50,000 "for the improvement of the Potomac River, between the Long Bridge, in Washington, and the city of Georgetown, in the District of Columbia." The necessary examinations and surveys were commenced, but were temporarily interrupted by one of the largest freshets on the river known for many years; subsequently they were resumed, and the contract for dredging awarded to a reliable company which had been engaged in the business for a long time. By section 4, Special Orders No. 120, Headquarters Corps of Engineers, Washington, D.C., November 2, 1870, Major William P. Craighill, Corps of Engineers, was directed to relieve me of the charge of the above improvement, which he did within a few weeks after.

BRIDGES.

Potomac Long Bridge.—An act of Congress supplementary to an act entitled "An act to authorize the construction, extension, and use of a lateral branch of the Baltimore and Potomac Railroad Company into and within the District of Columbia," approved February 5, 1867, makes provision and empowers said company to take possession of the Long Bridge. In accordance with the act of Congress authorizing the same, approved June 21, 1870, the bridge was formally transferred by me, acting on the part of the General Government, and placed in the possession of the company, subject to the considerations contained in the letter of the Chief of Engineers on the 8th of July, 1870. Subsequently, after having been released of the responsibility of its care and protection, the whole length of the structure, including road-way, crib-work, piling, railing and causeway, was to a great extent, more or less, damaged by the severe freshet of that year. So much destruction necessitated the company to entirely reconstruct the work.

Benning's or Anacostia Bridge.—This bridge having been almost rebuilt while in my charge, but occasional repairs were needed during the fiscal year. Being in constant use, however, and consequently subject to great wear and tear, much attention has to be bestowed upon it.

Navy-Yard Bridge.—The above remarks are equally applicable to the lower bridge over the Anacostia or Eastern Branch. It has been for many years a great thoroughfare. In my last report attention was called to the replacement of the present by a more permanent structure, one capable of sustaining a railway track and cars, at or near the present site; explanatory remarks and plans for which were submitted in compliance with a resolution of the Senate passed July 20, 1868.

Aqueduct Bridge.—This bridge remains in charge of the Alexandria Canal Company, subject to inspection by a competent officer. It remained in good condition, although greatly used, during the last fiscal year.

Little Falls or Chain Bridge.—This bridge, after having been greatly repaired and improved with the limited appropriation at my disposal, was again seriously damaged by the disastrous freshet during the summer of 1870. Several spans were washed away, and the structure rendered impassable. Estimates were submitted to entirely rebuild the superstructure, the stone piers being in excellent condition; an appropriation for that purpose successfully passed the House of Representatives during the session of last winter, but subsequently failed in the Senate in consequence of certain misrepresentations having been made as to the importance of the work.

PUBLIC SQUARES—RESERVATIONS—NATIONAL PARK.

For suggestions and plans in regard to the improvement and establishment of the public squares and reservations within the city limits, reference is again asked to the recommendations made in my last several annual reports. The amounts hitherto appropriated for their care are scarcely sufficient for the accomplishment of such cultivated labor as is absolutely necessary. No further action toward the establishment of a national park has been taken since my communication accompanied by the preliminary surveys and maps of certain tracts of lands adjoining or near the city, addressed to the chairman of the Committee on Public Buildings and Grounds of the Senate, relative to a suitable site for a public park and presidential mansion, submitted to accompany the bill (S. 549) for the establishment and maintenance of a public park in the District of Columbia, February 13.

Commencing with Lincoln Square, in the eastern portion of the city, and moving toward the western, the following statements will exhibit the nature of the works to which particular attention has been given.

Lincoln Square.—This "memorial square" has been inclosed with a paling fence, many choice trees and bushes have been planted and grass sown to form a sod. A plan has been prepared for laying out the grounds with tasteful beds and walks, the trees having been arranged in reference to it. The ground should be under-drained. Localities for miniature lakes and sites for statuary were selected. A watchman is already needed to protect the work already completed. No special appropriation having been made to continue the improvements, but little could be done during the year. It received, however, considerable care; additional trees were put out, the grass regularly cut, and the fence kept in good repair and white-washed. Very little could be undertaken toward embellishing that much neglected portion of the city, as no means were available.

East and West Capitol Grounds.—But little more was attempted with these grounds than to keep them in a cleanly condition. Some large sycamore trees, which had become old and decayed, were cut down and replaced by younger and more ornamental species. To the north of the Capitol, the space so long used as a place of deposit for and cutting of marble has been cleared up and graded; and that to the south is being filled up and the stables and sheds removed in anticipation of the further enlargement and embellishment of the grounds encompassing that magnificent building.

Botanic Garden.—This garden and its conservatories, over which the Joint Library Committee of the Senate and House of Representatives has special charge, has been very much improved. A brick fence has replaced the wooden one along Maryland avenue, and a portion of the main walk has been paved with flagging of Seneca stone. The central dome and one wing of a new conservatory have been erected.

Propagating Garden.—A large and well-arranged conservatory has been built, and connected with the old one; hot-air pipes were run throughout the same, and suitable shelving arranged for plants. The distributing office has been much enlarged by the addition of another story, plastered, repainted, and placed in complete order. Large numbers of flower-seeds have been assorted into packages and distributed. The labeling of the trees and shrubs, with their generic and specific names, have been directed, and the naming of the smaller reservations and triangular spaces have been recommended. The force of skilled laborers, authorized to be employed as gardeners, is not adequate to keep in proper order the many acres of public grounds scattered throughout the city.

Smithsonian Grounds.—An estimate was submitted for grading and laying out that portion of these grounds (Reservation No. 2) south of the institute, and for under-draining them; but no appropriation was made for the purpose. The greater part of the fencing, inclosing this much frequented place, has been repaired; a new carriage-way was opened, a large entrance gate being placed on the Twelfth street side, leading to the grounds of the Agricultural Department. This has proved of great convenience to the many visitors passing from the one building to the other. The gardeners were constantly employed in keeping the walks and drives well raked and cleaned, and the many acres of grass well cut.

Agricultural Grounds.—This reservation is constantly undergoing embellishments. Many trees have been planted, and a large conservatory erected.

Monumental Grounds.—Owing to the want of the necessary means, no improvements have been carried out. The Washington monument still remains in an unfinished state, work having been suspended several years ago.

The White Lot.—But little has been done during the year. Some portions were being filled up to the south of the new Executive avenue. A plan for laying out the reservation has been made and adopted.

In several previous reports it has been earnestly recommended that the whole extent of grounds referred to in the last few pages, generally known as "the mall," extending from the Capitol to the Executive Mansion, along the south side of the Washington Canal, and limited on the west by the Potomac River, should be converted into a park. The entire reservation is greater than any other within the corporation limits; is centrally located for the establishment of a limited one, and convenient to a very large portion of the city. The subject has been fully discussed on other occasions. A preparatory bill, necessary to carry out this object, was prepared and submitted by the chairman of the Committee of Public Buildings and Grounds of the Senate. It is to be hoped that the plan may be early matured, and thus convert these grounds, for the most part unembellished at present, into a benefit and pleasure, not only to the inhabitants of the city, but to all who desire to visit the capital of the nation.

Executive Grounds.—These grounds have undergone no material change during the year. The continuance of the Executive avenue, west of the mansion, and through to Pennsylvania avenue, will necessitate material changes. They have been kept in as good order as possible; the walks raked and rolled, the grass regularly trimmed, the fountain recemented on the exterior and interior faces, new jets substituted for the old ones, and the supply of water increased. The stable was enlarged for the accommodation of additional horses, repaired and repainted throughout, and placed in complete order. A number of new heating-pipes were arranged in one of the conservatories, and the grapery completed. Many rare plants and flowers were furnished for the conservatories; the latter prove a source of the utmost pleasure and gratification to all visitors.

Lafayette Square.—No more beautifully picturesque spot can be visited in the city. The trees and shrubs and bushes are of the choicest species, and most artistically are they arranged in inviting groups. A most charming place for recreation. It has but few defects; among them the absence of under-drainage, which is absolutely necessary, owing to the very level nature of the ground. A sewer-trap has been constructed at one of the angles, in anticipation of this being done at no distant day. A different material for the walks should be selected as soon as the necessary appropriations can be had, and the very high, unsightly iron fence should be replaced by a lighter and more ornamental one.

Franklin Square.—This square constantly improves as years are added to the growth of the trees and plants which ornament it. Laid out on more undulating ground, its appearance will soon contrast most favorably with that of Lafayette. During the fiscal year a light and handsome fence has been erected around it, replacing the old paling one. The walks have already been under-drained. New pavements were laid on K street, between Thirteenth and Fourteenth, and on Thirteenth and Fourteenth between I and K; also that on I street was mostly relaid. These pavements surround the square. K street, between Thirteenth and Fourteenth, has been parked, to correspond with the opposite side of the street, the space inclosed with an iron fence and planted with trees. The watchman's lodge has been repainted and placed in complete order.

Memorial Circle.—This circle, located at the intersection of Massachusetts and Vermont avenues, Fourteenth and M streets, was planned and laid out by me during the fiscal year. It has been inclosed by a light and tasty fence of iron. A pavement of flagging of Seneca stone, with a curbing of blue-stone, has been placed around it; several flag footwalks radiate from the latter to the angles of street intersections. The walks were under-drained and graveled, the necessary supply and waste-pipes laid from the center, in preparation for the reception of an antique fountain of terra-cotta stone, which had been selected for it. Choice trees and shrubbery were planted. In connection with the latter it may be stated that several distinguished gentlemen, who occupy beautiful residences surrounding the circle, set out memorial-trees as representatives of the growth of their respective States. The buckeye of Ohio, the white pine of New Hampshire, and the hemlock of Vermont, were among the number. This circle is a beautiful improvement to that locality, where already many fine buildings have been erected, and greatly enhancing the value of the property. It is situated at the intersection of two of the finest avenues in the city; also on a prominent street leading into the country, which has been for a long time the most fashionable drive.

Scott Square.—But little has been done during the year toward the future embellishment of the square for want of adequate means. It is pleasantly located on Vermont avenue, between I and K streets.

Farragut Square.—This reservation, on Connecticut avenue between I and K streets, has a corresponding position with the former in reference to Lafayette Square. Trees and shrubbery have been planted, supply and waste-pipes have been laid from the center in anticipation of the erection of a fountain, and foot-walks have been constructed. A pavement has been placed on I street, in front of the square, and a sewer built along one of its sides, between I and K streets, with the necessary traps.

The circles.—The circle on Pennsylvania avenue, at its crossing with New Hampshire avenue, has been kept in very excellent order, though no additional improvements have been made. The new one at the intersection of Massachusetts, Connecticut, and New Hampshire avenues, having been inclosed with a paling fence, has been graded, and a plan prepared for beautifying it. No appropriation for the same being available, nothing more was done.

Judiciary Square.—This square still remains in the same unfinished state, and it is to be hoped that some efforts will be made to have it embellished. Situated in the heart of the city, it should certainly receive the attention of Congress at an early date.

Triangular reservations.—The many triangular spaces caused by the crossing of the several avenues by lateral streets, especially those on Pennsylvania avenue, have been inclosed and planted with trees and shrubbery; each one should be named after some particular plant or tree. The experience furnished by the severe drought of two or three past summers shows the necessity of introducing a sufficient supply of water throughout the public grounds for the proper preservation of the growth of vegetation which adorns them. An abundant supply can be furnished for that purpose by the Potomac River, or by Rock Creek. It should be an object of interest to all to urge this important matter upon the proper authorities. The capital of the nation can be made one of the most beautiful and attractive spots in the country; it possesses unusual advantages as far as locality is concerned, and many other important and necessary and agreeable features, which are not often found concentrated in one city. It is therefore well to preserve in good order what already has been done. The iron fences around the reservations and squares have been twice painted during the year, and the wooden ones all white-washed.

Avenues and streets.—The repairing of the most important avenue through the capital had become an absolute necessity, and by an act of Congress, (Public 144,) approved July 8, 1870, provisions were made to have the greater part of the work executed. The commissioners appointed by said act to provide for the paving of Pennsylvania avenue, consisting of the Secretary of the Interior, the mayor of the city, and myself, met, organized by the election of a president and secretary from among their number, and proceeded to perform the duties devolved upon them. It was determined after examining the many different kinds of pavements presented for their consideration, very nearly a hundred in number, comprising wood, stone, asphalt, and other substances, and making personal inspection of those previously laid in Philadelphia, New York, and Boston, to adopt wood as the material to be used. It was decided also to select four kinds out of the number, each differing in the manner of being laid, and in mode of preserving the wood, so as to create competition among the inventors or owners. By this arrangement the entire work would be more carefully executed, as all the competitors would be anxious to use the paving of so long and broad an avenue as a favorable advertisement as to the superiority of their respective patents. The general charge of the work was placed in my hands. The Follansbee, Stowe, Miller, and Stafford pavements were selected, each assigned a section, equally long, and to be laid under precisely similar circumstances.

After sufficient time has been allowed to decide upon the relative merits of the different kinds, it will be interesting to prepare a report upon the same. By the 1st of January, 1871, not only the regrading and paving of the carriage-way of Pennsylvania avenue between the Capitol (First street) and the Treasury Department (Fifteenth street) was completed, but the curbing on both sides was reset and the foot pavement relaid on a uniform level throughout its length, a distance of more than one and one-quarter of a mile, with a width of 160 feet. All sign-boards were ordered to be removed from the sidewalks. The effect of these improvements soon became evident; the avenue is now one of the most magnificent drives in the world. With the limited means at hand efforts were made to keep it thoroughly clean. An act (Public No. 91) to authorize the paving and sewerage of M street was also approved June 21, 1870. As a member of the commission designated by said act, it may be necessary to state that proposals were invited to build sewers, and to lay a wood pavement, (the Stowe patent;) the work has been executed, and a second beautiful drive made the enjoyment of all. This street, in connection with the avenues, opens a stretch of wooden pavement, noiseless and easy, for several miles in length.

In a previous report it was recommended that some improved pavement should be selected for the avenue frontage of the Executive Mansion in place of the present cobble one; the same suggestion is made in regard to Seventeenth street, to prevent the interminable noise in front of the War and Navy Departments and the Government building at the corner of F street; Jackson and Madison Places, east and west of Lafayette Square, should also be paved. A commission, consisting of the mayor, Architect of the Capitol Extension, and myself, was appointed by direction of Congress to examine and report upon the establishment of suitable grades for the several streets radiating from the Capitol building; a careful survey was made in accordance with their views, and a plan recommended for adoption.

The regrading of the streets encompassing the Patent-Office and Post-Office buildings has previously been suggested.

The special committee of which the Architect of the Treasury Department and myself were members, appointed to reconsider a change in the grade of the street adjoining the Treasury Department, examined the subject and prepared a report. The corporate authorities subsequently authorized the laying of the Scharf pavement on Fifteenth street, between Pennsylvania and New York avenues. Appropriations have been made to unite the cities of Washington and Georgetown by connecting West and P street by a bridge over Rock Creek; the work will be completed by the end of the year, and another beautiful and convenient drive afforded the citizens of the two cities. The roadway of the Executive avenue, between the Treasury and Navy Departments, south of the Executive Mansion, has been macadamized, the iron fence on the north side very nearly completed, and a very handsome pavement of Seneca flagging laid along it. From the want of a sufficiently large appropriation the work upon it had to be suspended. That portion of Massachusetts avenue between Fifteenth and Sixteenth streets, and in front of that beneficent institute Louise Home, founded by Mr. Corcoran, was made to conform to the established grade, and thereby an easy approach to the building was obtained. Many hundreds of minor improvements, such as drains, sewer-traps, street-crossings, and general repairs, were executed.

PUBLIC BUILDINGS.

The superintendents of the Capitol, Post-Office, Patent-Office, Treasury, Government office on Seventeenth street, Agricultural Department, War and Navy Department buildings, each submit their annual report of the same. The board of officers ordered to prepare plans and estimates for a new War Department building, and for a fire-proof structure to preserve the valuable archives which have been accumulating for years, as well as the commission authorized to select a site and proposed plans for a new State Department, upon both of which it was my duty to serve, after several meetings, at which these subjects were discussed, submitted reports upon the same. A great quantity of work was executed under my direction in and about the Executive Mansion and the conservatories adjoining. The exterior walls received two coats of paint; the copper roofing of the main building was entirely repaired; many alterations were made in the interior for convenience and improvement, among them additional bath-rooms, new stairways, a billiard-room, and a large and improved cooking-range constructed in the kitchen. The whole of the wood-work was repainted, the walls of many rooms repapered, and the main hall at the entrance handsomely frescoed. In the conservatory several alterations were made for the better preservation of the plants, and many additions were made to the latter. Many beneficial changes were made in the garden, and in the out-door conservatory. Many needed renewals of furniture were supplied, and beautiful services of plate and glass purchased for State occasions. The house is a large one, occupied for both official and domestic purposes, and it would seem but proper and right that liberal appropriations be made in order to preserve the dignity and elegance of the establishment.

WASHINGTON CANAL.

An act of Congress approved July 15, 1870, enacts that the mayor of the city of Washington, the Secretary of the Interior, the Architect of the Capitol Extension, the engineer officer in charge of public buildings and grounds, together with two men to be appointed by the mayor of the city of Washington, by and with the advice and consent of the board of aldermen of said city, should be appointed a commission "who shall cause the Washington Canal, either in whole or in part, to be dredged, or, if decreed best, dredged and narrowed, or arched and converted into a sewer."

After many meetings of the commission, personal inspections of the canal, and many views exchanged, it was decided finally to invite me to submit a report, and furnish plans and estimates for the proposed improvement. The papers are to be found among the files containing the proceedings of the commission. A contract was made with very responsible parties to undertake the work. The control of the whole matter was subsequently by an act of Congress placed in the charge of the Board of Public Works, appointed under the law establishing a territorial form of government for the District of Columbia. Upon the day the board assumed its functions, by Special Orders No. 195, War

Department, Adjutant General's Office, Washington, May 18, 1871, Major O. E. Babcock relieved me "of the charge of the public buildings and grounds, and certain public works in the District of Columbia," and any other duties in my hands, to take effect on the 1st of June. The same orders directed me, upon being relieved, to proced to Headquarters Military Division of the Pacific, and to report to Major General Schofield for duty as engineer officer upon his staff, relieving Major N. Bowen. Previous to being relieved the board of officers, being a member of the same, proceded to Newburgh to inspect the model of the equestrian statue of General Winfield Scott, designed by Mr. George Brown of that city; the model was accepted, after several alterations had been suggested by the different members of the board, and a contract entered into for casting the same in bronze from cannon captured in Mexico.

WASHINGTON AQUEDUCT.

From the date of my last report, until the 19th of November, 1870, the date upon which the charge of the aqueduct was turned over by me to Major George H. Elliot, the following statement exhibits the amount of labor accomplished on this important work. At the Great Falls of the Potomac a force was engaged in removing rocks, trees, and bushes from the pool above the dam, until the weather became too cold to work with advantage; the work was suspended on the 21st of November. The macadamizing and widening of the road over the conduit, between bridge No. 3 and the distributing reservoir, progressed during the month, and by the end of November the total amount done during the season of 1870 was 10,630 linear feet. At the receiving reservoir the lining of Dalecarlia tunnel with bricks progressed in a satisfactory manner, there being at the end of the month 103 feet of semicircle and 10 feet of whole circle to build. The employés of the aqueduct regulated the flow of Potomac waters in the conduit and reservoirs, and supervised the general distribution in the cities of Georgetown and Washington, besides making the repairs incidental to the bridges and pipe lines. In the office of the Washington Aqueduct, under my directions was prepared, an estimate of the cost of furnishing and laying a cast-iron main of 36 inches in diameter from the distributing reservoir to Capitol Hill. Plans and estimates were also prepared for furnishing and erecting a steam-pump and boiler in the abutment of Rock Creek Bridge, for the better supplying of Georgetown Heights with Potomac water. A contract was made for the same, and the improvement has since been completed.

My duties, with the exception of the settlement of my accounts, and the completion of this report, terminated on the 1st of June, 1871, having been first assigned to them by the Engineer Department on the 13th of March, 1867; upon that day I entered upon their performance, "the charge of the public buildings and grounds, the superintendency of the Washington Aqueduct, and all the public works and improvements of the United States in the District of Columbia, not otherwise provided by law," having, by an act of Congress, approved March 2, 1867, devolved upon the Engineer Bureau.

I am, general, very respectfully, your obedient servant,

N. MICHLER,
Major of Engineers, United States Army.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. A., Office of the Chief of Engineers,
Washington City, D. C.

During the summer of 1870 there were two
parties engaged in Lake Superior, leaving De
June. The steamers Search and Surveyor we
charge of Captain J. A. Smith and First L
Corps of Engineers, while the chiefs of prima
tenant E. H. Ruffner, Corps of Engineers, and
G. T. Wisner, and A. R. Flint.

The primary triangulation was carried west
Station Wheal Kate, on Kewenaw promontor
the north shore of Lake Superior, a distance
thirty miles. Nine primary stations were oc

The progress was not entirely satisfactory;
causes: first, from error in selection of two
bad quality of two of the theodolites. These
of Berlin, and are numbered 2561 and 2563 r
inch instruments, reading by microscopes to
to do the most accurate work. One can be us
(accidental errors of graduation amounting t
requires a great number of readings to obtai
other, No. 2561, is nearly worthless from bad
and either is a disgrace to any maker.

The primary parties observed for latitude a
from Station Wheal Kate by powder-flashes.
charge of the steamer Search, moved the prin
to station, supplied them with provisions, an
stations. He found it impracticable to compl
at the west end of the lake. He was aided
season by Assistant A. C. Lamson.

First Lieutenant J. H. Weeden, in charge were made between the standard 15-feet brass bar of the survey and the tubes of the base apparatus, (Bache's compensating base apparatus.) The daily results were quite discordant, and it was not till I noticed their dependence on the temperatures that any explanation could be found for them.

At first I supposed it to arise from under-compensation of the base tubes; but on carefully examining the question, after returning to the office in the winter, a part of the error was found to be in the constant of expansion (0.00180 inch) previously determined for the brass bar.

The measurement of the base was begun August 13, and finished August 30, in eleven working-days, the greatest number of tubes measured in one day being two hundred. The greatest grade was four degrees and twenty minutes, the ground varying in height from two to fifteen feet above the lake. The soil was very favorable, being almost pure sand. The length of the base reduced to the level of the sea is, provisionally, 19,870.075 United States feet. That length depends on the assumption that the length of the 15-feet brass bar, at 62° Fah., is 179.99997 United States inches. This value needs a correction, which will be applied when some new standard yards, now under construction at the office of weights and measure, are received. (See Appendix A.)

During the measurement I took charge of the contacts and readings, Lieutenant Weeden gave the line, Assistant E. S. Wheeler had charge of the foot-plates and grades, and Mr. E. J. Knight recorded. All readings, except of the contact-level, were taken independently, by two persons.

To all my thanks are due for their zealous co-operation.

The last day's work of 124 tubes, or 1,860 feet, was measured by Lieutenant Weeden; the difference between the measurements was 0.21, (twenty-one hundredths of an inch.)

A point was subsequently taken near the middle of the base, and the lengths of the two parts determined by triangulation from the whole base; the deduced length of one part was 0.96 inch greater, and of the other 0.89 inch less than the measured lengths of the two parts, each part being nearly 10,000 feet long.

On October 10 the parties were withdrawn from Lake Superior, having been able to do very little work for two weeks previous.

On May 22, 1871, primary parties, under Assistants G. T. Wisner, A. R. Flint, and G. A. Marr, were sent to Lake Superior on the steamer Search, to complete the work at the west end of the lake. About ten days were consumed in going over some bad shore-line work done by the party under Lieutenant Griffith in 1868.

The work at the west end of the lake was then begun, and completed in July, when the parties were moved to the middle of the lake to re-read the angles coming off the Kewenaw base.

The work done at the west end of the lake was the occupation of ten primary stations; latitude determinations at four stations; azimuth determinations at two stations; the carrying of longitude by powder-flashes to the North Base Station near Du Luth; observations for telegraphic determination of longitude between St. Paul and North Base Station by Assistant Flint and myself, and between Detroit and North Base Station by Assistant O. B. Wheeler at Detroit, and Assistant Wisner and myself at north base station, Du Luth. The longitude connection between Du Luth and Detroit took up so much time (nearly a month being required to get three good nights' work) that I was compelled to leave Du Luth before its completion, thus necessitating two observers at that place. Personal equation between myself and Mr. Wisner was,

1870.—Owing to the late date of the passag
in 1870, for the lake survey, the best part of t
of May and all of June and July, was lost, as
into the field till the appropriation had been n

Leaving as soon as they could be organized
the passage of the bill, they reached their stat

The following were the parties in Lake Mich

1st. Shore-line party under First Lieutenant
of Engineers, aided by Assistant G. A. Marr
began work at Little Point, Au Sable, on the
the survey had reached in former years, and h
teen miles by September 9, where, with his
to Lake Champlain.

2d. Hydrographic party on steamer Ada, ur
N. Lee, aided by Assistant L. Foote.

Lieutenant Lee carried the off-shore hydrog
southward sixty-four miles, reaching a point si
boygan; at north end of lake, near Manistiqu
miles, and around Little Point Au Sable, a d
doing much good work under unfavorable circum
also ran several lines of soundings across the
however, from the high winds and rough wa
months on Lake Michigan. In addition to t
parties on Lake Michigan from camp to camp,
provisions.

3d. Shore-line party under Assistant J. R.
Mayer. Mr. Mayer began work on west shore
Manitowoc, where previous work had closed, a
phy and in-shore hydrography southward fo
parties were withdrawn from the field. They
26, 1870.

Lieutenant Powell completed the hydrography of the north end of Lake Michigan on August 5, discovering a shoal not on the lake survey charts, seven miles south of Mille Coquins, with but eleven feet of water on it, and another half way between Waugoshance Light and Waugoshance Island, with but 8 feet of water. Lieutenant Powell's report will be found herewith. (Appendix B.) At the date of this report, Assistant Mayer had carried his shore-line southward fifty miles, to a point ten miles south of Milwaukee. Assistant Foote and Assistant Custer had carried the shore-line on the east shore south about one hundred and twenty-five miles, to the vicinity of New Buffalo; the development of Assistant Foote's shore-line reaching one hundred and fifty-three miles. Owing to bad weather, and the late day at which Lieutenant Lee received his instruments, the lines of azimuths and latitudes are not yet completed. It is hoped that better weather will be had in October.

6th. On May 18, 1871, Assistant E. S. Wheeler was sent to Green Bay, Wisconsin, to make a reconnaissance for a series of triangles to connect those in Green Bay with Lake Michigan at Milwaukee. He succeeded in finding positions for the stations, nearly all of which are already erected, and a part of the angles will be read this fall. The chain reaches over a distance of about one hundred and twenty miles, and has been energetically pushed forward by Assistant Wheeler.

Assistant Custer's report of this summer's work is submitted herewith, (Appendix C,) as it gives a sketch of the methods used in topography and in shore hydrography on the lake survey.

III.—LAKE ST. CLAIR.

As the triangulation of Lake St. Clair had never been done, and as a part of its hydrography and forty miles of its shore-line was still incomplete, on the 10th of April, 1871, I directed First Lieutenant W. R. Livermore, with shore parties under Assistants J. R. Mayer and A. C. Lamson, to complete the survey of the lake. Subsequently, the steamer Ada, under First Lieutenant J. H. Weeden, and the steamer Search were sent to the same work.

The work was pushed with energy by Lieutenant Livermore, and completed by the time it was advisable to send parties into the larger lakes.

This survey affords the means of constructing a map which shall reach from Lake Huron to Detroit.

The marshes around Lake St. Clair gave rise to a good deal of malarial sickness even at this early season.

A special survey of the St. Clair Flats Ship Canal was made in the fall of 1870, under the direction of the Chief of Engineers, United States Army, by Lieutenant A. N. Lee, Corps of Engineers. The survey was plotted and a copy of the map forwarded to the Chief of Engineers, December 1, 1870.

IV.—LAKE CHAMPLAIN.

On the 9th of September, 1870, Lieutenant W. R. Livermore with his party was transferred from Lake Michigan to Lake Champlain, to make a survey of Plattsburgh and Burlington Bays. He was aided by Assistants Marr and Foote, and completed Plattsburgh Bay, and nearly completed Burlington Bay by the close of the season's operations, November 12, 1870.

In May, 1871, Lieutenant E. Maguire completed, with his party, the survey of Burlington Bay, and commenced the survey of the narrows at the south end of the lake. The field-work of the latter is now completed, and covers thirteen miles of the southern end of the lake. Lieutenant Maguire's report is submitted herewith. (Appendix H.)

V.—ST. LAWRENCE RIVER.

On the completion of the survey of Lake St. Clair, in May, 1871, First Lieutenant W. R. Livermore, with his party, and that of Assistants Lamson and Towar, were sent to the St. Lawrence River to commence its survey at the northern boundary of New York, and work toward Lake Ontario. At the date of this report the shore parties have reached a point ten miles southwest of Ogdensburgh. The reconnaissance for triangulation has been carried from the northern boundary of New York to the east end of Lake Ontario, and a larger part of the stations erected.

The angles are now being read. Assistant Lamson reports the development of the shore-line surveyed by him in the St. Lawrence this summer as ninety-nine miles; Assistant Towar reports the development of the shore-line surveyed by him in the St. Lawrence this summer as one hundred and thirty-four miles.

VI.—OFFICE.

During the winter the question of standards, their coefficients of expansion, and those of the tubes of the base apparatus, was taken up.

There are in the office of the Lake Survey five brass yards, numbered from one to five, made by Würdemann in 1867, with the amounts by which they are longer or shorter than the United States standard yard marked upon them. That standard United States yard is the distance between the twenty-seventh and sixty-third inch on an 82-inch brass scale made by Troughton, now in the Office of Weights and Measures at Washington, the standard temperature being 62° Fahr. (See Ex. Doc. No. 27, third session Thirty-fourth Congress, page 4.)

These yards have rectangular cross-sections of 0.98 by 0.37 inches, and at one end a cylinder 0.1 inch long, whose diameter is the thickness of the yard.

I obtained from the Coast Survey, through the kindness of Professor Hilgard, a contact level comparator Baumann, marked No. 1, and as the errors of the thermometers with the base apparatus were unknown, I obtained from Würdemann a standard thermometer. Those errors exceeded 1°.

Soon after beginning the comparisons, from the pressure of other duties, I found it impossible to give to them the time needed; thereafter the observations were made under my general direction by Assistant E. S. Wheeler, aided from time to time by Sub-Assistants Towar, Mickle, and Russel. The first thing done was the determination of the length of the 15-feet brass bar in terms of the distance between the extreme end surfaces of the five brass yards when placed together in a right line end to end. Both bar and yards were aligned by means of a fine copper wire, strained to nearly its breaking point by a known weight, its sag at middle being computed and allowed for. The bar and yards were side by side, supported on independent rollers, in a box, which was closed to avoid sudden fluctuations of temperature. At first the ends of the yards were kept in contact by clamp-screws, but finding that this produced a compression that might amount to one four-thousandth of an inch, without its being possible to detect it, I had the clamps changed for spiral springs, adjusted to give a pressure of two pounds between the ends of contiguous yards.

A series of experiments on the change in distance between the extreme ends of the yards produced by deviation at the joints between the yards from a right line, showed that the actual change was but about one-third the computed change; and that where the deviation did not exceed one-hundredth of an inch, (about the limit of accuracy of adjustment,) the resulting error was within the ordinary error of observation.

I should state that two comparators were mounted on stone posts, and the objects to be compared were supported between them on two trestles of the base apparatus, one of the comparators being kept at a constant reading, and only its level being observed. The yards having been first placed in the order of their numbers, and a sufficient number of differences between their combined length and the length of the 15-feet bar having been obtained, the order of the yards was changed and a new set of differences obtained. Several orders were tried in this way, and discrepancies found between the results, which could only be accounted for by the supposition that the part of the ends of the yards which come in contact were either very irregular or were not normal to the center lines of the yards. These end surfaces were then investigated by measuring elements of a cone, whose base was the surface of contact at one end of a yard, and its vertex the center of the surface of contact at the other end. The ends were found to be quite irregular, and on computing from these measurements the sum of the distances by which the contiguous ends of the center lines of the yards, when arranged in the order 1, 2, 3, 4, 5, were separated from each other by the irregularities on the ends of the yards, it was found to be approximately one-thousandth of an inch. While this is but an approximate value, it may yet be too small; it is impossible to determine its precise amount, and therefore impossible to determine from the length of the center lines of the different yards the distance apart of their extreme ends when placed together in line, or the length of the 15-feet bar in terms of the yards.

When the examination of the yards commenced, the lengths of their center lines were compared, and differences, varying largely from those marked on the yards were found between them. Thus, yard No. 5 was marked "exact," and yard No. 3 was marked $\frac{5}{20000}$ long. Our comparisons made it $0^{in}.00035$, the shortest thus differing from the marked lengths of No. 3 by $\frac{6}{10000}$ inch. Similar discrepancies were found in the relative lengths of the other yards, though not to so large an amount.

So great a discrepancy threw doubt on the values of all the yards, and, under orders from the Chief of Engineers, I proceeded to Washington to compare yards No. 5 and No. 3 of the Lake Survey with the United States standard yard. In the comparisons I received every facility from Professor Hilgard, and was aided by Mr. W. H. Clark, of the office of weights and measures.

That standard is a line measure, and the office of weights and measures did not have the conveniences for comparing it and an end-measure yard with the greatest degree of accuracy. The results, however, showed that No. 5 was probably correct within $\frac{2}{10000}$ of an inch, and that the error was in No. 3. The subsequent discovery of the irregularity of the end surfaces of the yards showed that no final and satisfactory value could be obtained for the 15 foot brass bar from them, and application was made to the office of weights and measures for five end-measure yards. These are to have small contact surfaces of agate, and it is hoped will enable us to obtain an accurate value for our 15-foot bar. In the mean time the sum of the lengths of the center lines of the five yards (No. 5 being taken as exact) is provisionally assumed as the distance between the extreme ends of the yards when placed in line in the order 1, 2, 3, 4, 5. That sum is 179.99890 United States inches, and is less than the distance between the ends of the extreme yards in the above order by the sum of the intervals between the ends of the center lines, an amount that cannot be determined, and may, as already stated, reach $\frac{1}{1000}$ of an inch. It was thought better to take the sum of the center lines without correction than to attempt by guess to correct it.

The comparisons of the 15-foot bar with the yards placed end to end in the above order made the bar .00107 inch the longest; its length is, therefore, taken provisionally, as 179.99997 United States inches, and with this length the Minnesota Point base is provisionally computed.

The expansion of the 15-foot brass bar was found in two ways: 1. From comparator readings at high and low temperatures, usually twenty-four hours apart, trusting to the stability of the stone piers rising from the cellar in the interval. 2. By placing the five yards, clamped together, in a box kept filled with pounded ice, and comparing the bar with the distance between their extreme ends as a fixed length while the temperature of the room and of the bar was raised through many degrees.

I give most weight to the second method, as the bar passed through its maximum length slowly, and there was no probability of error from change of position of piers; the two results are, however, the same, and give expansion of 15-foot bar for 1° Fahr. .00174 inches.

The expansion of the five brass yards, while lying beside the brass bar at high and low temperatures, was found to be .00002 inch greater than that of the bar, giving expansion of five yards, clamped end to end, for 1° Fahr., .00176 inch.

The relative expansions of the two tubes of the base apparatus were found by comparisons at high and low temperatures of the base tubes with the 15-foot bar, and were, for tube No. 1, .00160 inch; for tube No. 2, .00172 inch, giving absolute expansion for 1° Fahrenheit, tube No. 1, .00014 inch; tube No. 2, .00002 inch.

It is believed that the error in none of the above expansive determinations exceeds unity in the fifth decimal place. Details are given in Appendix D.

Meteorological observations have been continued at the following stations: Superior City, Wisconsin; Milwaukee, Wisconsin; Detroit, Michigan; Monroe, Michigan; Cleveland, Ohio; Erie, Pennsylvania; Buffalo, New York; Fort Niagara, New York; and Charlotte, New York. The means of these observations are given in Appendix E.

As at several of the stations meteorological observations have been carried on for ten years or more, they should furnish data for determining the periodic functions which best represent the observations.

Accordingly, I have had computed for several places the coefficients and arbitrary terms of an expression which gives the mean temperature of any day in the year, so far as that depends on the mean monthly temperatures. Its simplest form is $t = A + B_1 (\sin \theta + c_1) + B_2 \sin (2\theta + C_2) + B_3 (\sin 3\theta + c_3) +$ where A, B_1, B_2, B_3, &c., C_1, C_2, C_3, &c., are known, and θ is the time from the arbitrary origin (converted into arc at the rate of 360° per year) at which the temperature t is desired. From this expression the times of its maximum, minimum, and mean values are computed. These tables are given in Appendix E. The reduction of the meteorological and water-level observations was in charge of Assistant D. F. Henry until his resignation, and since in charge of Assistant O. B. Wheeler.

The Chief Engineer's letter of April 29, 1871, desired the investigation of tides and of the phenomena known as seiches. The pressure of longitude work during the summer has been so great as to prevent anything but a beginning. The work will be carried on during the coming year.

The phenomena known as seiches consist on the great lakes of a series of waves rolling in on shore at intervals of twenty or thirty minutes for several hours, the height of the crests of the waves above the valleys sometimes exceeding 2 feet, though usually smaller, the phenomenon often occurring when the lake is perfectly smooth and without immediately preceding atmospheric disturbance at the point of observation. Among the various causes assigned for the phenomenon, such as earthquakes, general barometric depression or elevation, &c., there is one which I have never seen suggested; that is probably a true cause, though perhaps not the sole cause, of the phenomenon in question.

It is well known that tornadoes frequently occur in the northern United States, the destructive portion of the tornado being a circular storm of about one-eighth of a mile in diameter, moving at the rate of thirty or forty miles an hour. In a cyclone the barometer at its center sometimes falls 2 inches. When tornadoes strike buildings those buildings are frequently burst open by a force apparently acting from within, and with violence. In all probability there is, then, in violent tornadoes a barometric depression which may amount to 2 inches as their violence equals or exceeds that of the cyclones. Should such a tornado strike the lake, the barometric depression at its center being 2 inches, the water of the lake would rise then 2 feet above the mean level of the lake, and the disturbance would give a wave double that height, counted from valley to the crest.

This disturbance of the water traveling on at the rate of thirty miles an hour, would give a succession of waves spreading over the lake, as the disturbance caused by a steamboat in motion does. The dimensions of the waves would be modified by the distance, depth of water, and form of the shore as they traveled toward a distant point. It is to be hoped that some tornado may be observed near enough to one of our self-registering tide-gauges to ascertain its effect on the latter.

During the winter of 1870–'71, Captain J. A. Smith had charge of the repairs of steamers, tents, equipage, and of the fitting out for the summer's work. He also had practice in magnetic work. He was relieved from duty on the Lake Survey on April 1, 1871.

First Lieutenant W. R. Livermore, aided by Assistant G. A. Marr during the winter, computed and plotted the work of Lieutenant Livermore's party in Lake Michigan and Lake Champlain. Lieutenant A. N. Lee plotted the summer's off-shore hydrographic work of his party, and was subsequently engaged in fitting out parties for the summer's work and in practice in the observatory. Lieutenant J. H. Weeden, aided by Assistant Lamson, computed the summer's work of his party in the Apostle Islands, and Mr. Lamson plotted it. Subsequently Lieutenant Weeden computed the length of the Minnesota base, and had some practice with magnetic instruments.

Assistant O. B. Wheeler had general charge of the revision of computations and of the longitude work during the summer of 1871 at Detroit. He was aided, from time to time, by Sub-Assistants Burton, Mickle, Russell, Kummel, and Eisenmann. The longitude work embraced the determination of the difference of longitude by telegraph between Detroit and the following points: Washington, District of Columbia; Austin, Nevada; Baute Mountain, Nevada; Duluth, Minnesota; and Fort Leavenworth, Kansas.

The results of the work with Washington are given in Appendix F. I am much indebted to Admiral B. F. Sands, Superintendent of Naval Observatory, for his aid and courtesy, not only in connection with the longitude work, but at other times during the year. To Professor Eastman, of the Naval Observatory, my thanks, in behalf of the survey, are also due.

The longitude work with Austin and Baute Mountain, Nevada, was in connection with a party under the charge of Lieutenant G. M. Wheeler, Corps of Engineers; at Fort Leavenworth the connection was with Lieutenant E. H. Ruffner, Corps of Engineers.

Assistants Wisner and Flint computed during the winter the triangulation of the summer in Lake Superior, the base-line on Minnesota Point, and the latitude and longitude work of the summer in Lake Superior. The results of the latitude and longitude work are given in Appendix G.

Assistant J. R. Mayer, aided by J. P. Mayer, computed and plotted his work of the summer preceding.

The reduction of the detailed sheets to the final maps for the engraver has been carried on during the year by Mr. J. N. Mueller and Edward Molitor.

Mr. Mueller has completed sheet No. 2 of Lake Superior, and has sheet No. 1 nearly completed, while No. 3 is in progress. All are on a scale of $\frac{1}{400000}$.

Mr. Molitor completed the reduction and engraving on stone of Preliminary Chart No. 3 of Lake Superior (now published) on a scale of $\frac{1}{400000}$, and a final chart of Isle Royale on a scale of $\frac{1}{120000}$. He is now occupied on a chart of the St. Clair River.

In the spring two theodolites, with 14-inch horizontal limbs, were received from Pistor & Martin and Houghton & Simms, respectively; they have proved to be of the first class. A smaller theodolite, (12-inch,) by Houghton & Simms, just received, has not yet been sufficiently tested to judge of its quality. Advantage was taken of the deep-sea soundings in Lake Superior during the summer to have dredgings made by Professor S. S. Smith, of Yale College. His report is not yet received.

The following changes in the engineer officers under my command were made during the year:

Captain J. A. Smith relieved from duty on Lake Survey April 1, 1871.

First Lieutenant E. H. Ruffner relieved from duty on Lake Survey November 30, 1870.

Second Lieutenant E. Maguire reported for duty on Lake Survey May 6, 1871.

Second Lieutenant C. F. Powell reported for duty on Lake Survey May 6, 1871.

The following appendices accompany this report:

A. Notes on Minnesota base.
B. Reports of chiefs of parties.
C. Report of Assistant Custer on shore-line work.
D. Report of Assistant E. S. Wheeler on constants of base apparatus.
E. Report of Assistant O. B. Wheeler on meteorology.
E^1. Report of Assistant O. B. Wheeler on meteorology.

F. Report of Assistant O. B. Wheeler on difference of longitude—Washington and Detroit.

G. Report of Assistant O. B. Wheeler on latitudes and longitudes—Lake Superior.

H. Report of Lieutenant Maguire on survey of Narrows, Lake Champlain.

I. List of charts issued during year.

K. Progress sketch, in duplicate.

Last year the appropriation for the Lake Survey was made so late that the parties did not reach Lake Michigan till August 1, losing the favorable months of May, June, and July, and working in the unfavorable ones of the fall, when winds and smoke prevail. Work done at that time costs nearly double what it would in the early summer, and I would therefore respectfully urge the necessity of the appropriation being made in May to become available at once.

In conclusion, I wish to express my hearty thanks to the officers and assistants of the Lake Survey for their cordial aid and co-operation in the prosecution of the work.

Very respectfully, your obedient servant,

C. B. COMSTOCK,

Major of Engineers, Brevet Brigadier General.

Appendix A.

NOTES ON MEASUREMENT OF BASE ON MINNESOTA POINT, NEAR DU LUTH, MINNESOTA, JULY AND AUGUST, 1870.

The base apparatus used was the compensated one of Bache, made by Würdemann. The operation is of two parts: namely, the comparison of the tubes of the base apparatus, both before and after the measurement of the base with the standard of length, and the actual measurement of the base with the base apparatus.

The standard of length was a brass bar 15 feet long, with agates inserted in its ends; the tubes were also 15 feet long. Two contact-level comparators were mounted on stone posts 15 feet apart, and the tubes and 15-foot bar alternately brought between them; the difference of readings of the comparators gave the difference of length of bar and tube.

One of the comparators, Coast Survey No. II, made by Baumann, was kindly loaned me by Professor J. E. Hilgard; the other, made by Würdemann, is the property of the Lake Survey.

Comparisons.—The comparisons of the tubes of the base apparatus, with the 15-foot standard brass bar, were made on the basement of the house of Mr. Robbins, at Superior City. This basement was a large store-room, say 25 feet by 60 feet, with its floor about 2 feet above the ground, the soil being muddy and compressible. Holes were cut in the floor 15 feet apart, and brick piers 2¼ feet square sunk 2 feet into the soil. On these the stone bases (about 2 feet square and 9 inches thick) of the comparator-posts were placed, and on these bases the comparator-posts, which were keyed to an iron rod in their interior, rising from the centers of the bases. The tops of the triangular (8-inch sides) stone comparator-posts rose to a convenient height (about 3 feet) above the floor. Vibrations from steps affecting the steadiness of the posts, the earth was subsequently removed from the sides of the brick piers, and dug away beneath the floor-timbers, so that none of them should touch the ground within 6 or 8 feet of the piers.

This improved their stability, which, however, was never good. The brick piers ought to have been carried down to the firm clay underlying the surface soil.

During comparisons the tube between the comparators was supported by two trestles of the base apparatus, these trestles resting on their foot-plates, which lay on top of brick piers carried down into the soil. Two comparators were used. At first both comparators were read; but subsequently the Coast Survey comparator was set at a fixed reading and used as a but-piece, only its level being read. This saved time and made the differences depend on a single comparator. The comparators were screwed to nuts leaded in holes in the top of the comparator-posts. Once the leading and its comparator (C. S. II) were found to be loose, vitiating preceding results. The standard bar in its box was laid upon wooden saddles resting on top of tube of base apparatus, the saddles being firmly tied to the tube, and the ends of the bar directly over the agates at the ends of the tube. One man at each trestle raised or lowered the tube, and with it the bar, till the centers of the ends of one or the other were precisely opposite the center of the ends of the quills of the two comparators. That this adjustment be accurate is of importance. For the bar, if the adjustment be perfect at one end, while at the other the center of the quill deviates from the center of the end of the bar by .06 inch, the bar will appear too long by .00001 inch, and the error increase as the square of the deviation; for the tube, supposing a deviation at the end where the agate knife-edge comes in contact with the comparator quill, with end rounded to a radius of about .5 inch, a deviation of .06 of an inch would make the bar appear too short by .00361 inch. Here there is a fruitful source of error, if the greatest care is not used in adjusting the position of the tube in reference to the comparator quills.

In the early readings considerable errors arose in this way. The radius of the quill end which comes in contact with the knife-edge of the agate of the base tube should be much longer.

As the 15-foot bar was easily sprung out of a straight line, both horizontally and vertically, its straightness was tested by stretching a fine copper wire over an upper edge of the bar, the strain on the wire being near its breaking strain.

The wire lies accurately in a vertical plane, and by placing a small straight edge of metal, and snapping it against the wire, where it just makes it sound, the bar is in position at that point. The wire was .028 inch in diameter, with a strain of 10 pounds, about two-thirds its breaking weight; the calculated sag is .04 inch; allowing for this, the edge of the bar can be brought to a straight line by wedges under the box, or by straining it sideways by wooden buttons screwed to the saddles, and turning about their screws. The apparatus working badly, after several days' work, it was decided to take it apart, clean it, see that the rollers were free, &c. The bubble in the sector level of one of the tubes being too long on cold days, it became necessary to refill the level, and as it was not possible to replace the level in its case precisely as it was before, the length of that tube was changed, and previous work on it rendered valueless. It will be best hereafter to do all this before beginning comparisons.

We had two comparators, one with a but-piece not giving so good results as two, as found by the experience of the Coast Survey and the Lake Survey. Very careful and strong men are needed at the trestles during comparisons, as the tube in being lowered is apt to get away from the men, and come down with a run. One agate was knocked entirely out of its bearer, and one loosened during the comparisons before measurements, through carelessness; fortunately we were able to replace them, and by burnishing down the brass in which they set, made them firm, so that they served perfectly well for the measurement of the base.

No comparisons were ultimately relied on where the bar did not reach a maximum length, and the thermometers remain practically stationary for an hour at that maximum. In spite of all attempts to get rid of them, there were variations in the differences, as determined on different days, much exceeding the errors of observation. On making the comparisons after the measurement of the base, it was noticed that the irregularities appeared to depend on the temperature, and it occurred to me that the tubes might not be compensating. The supposition that the tubes were not perfectly compensated would in part account for these errors, but so would an error in the expansive coefficient of the 15-foot bar. The discrepancies made a subsequent examination of both points necessary.

So much time was lost by the knocking out of the agates, the discovery at one time that the Coast Survey comparator slide had play, and the cleaning of the apparatus, that the comparisons extended from July 22 to August 9.

The comparisons, after the measurement of the base, extended from August 31 to September 2. The comparisons were made by General Comstock and Assistant E. S. Wheeler, with Mr. E. J. Knight as recorder. John Klein and Frank Divroode were at the trestles after the first few days. Much credit is due Mr. Wheeler for his valuable assistance, and to all the rest for cheerful co-operation and hard work. The length of the 15-foot standard bar has not yet been accurately determined, but results, assuming its length for the present at 62° Fahr., as 179.99997 United States inches.

Tube No. 1 was, by 25 comparisons before measurement, 179.96860 inches.

Tube No. 1 was, by 16 comparisons after measurement, 179.96584 inches.

Tube No. 2 was, by 23 comparisons after measurement, 179.98594 inches.

Tube No. 2 was, by 36 comparisons after measurement, 179.98534 inches.

The cause of the change of length of tube No. 1 during the measurement of the bar is unknown.

The maximum error which that change could introduce into the length of the base is .9 inch, or $\frac{1}{260000}$.

Using the value given above for the length of the standard 15-foot bar, the resulting length of the base is, reduced to sea-level, 19870.075 United States feet. This is but a provisional value, as it depends first on the assumption that the one of the five brass yards made for the Lake Survey by Würdemann, and marked "No. 5, exact," is an exact

United States yard at 62° Fahr.; second, on the assumption that when the five brass yards are placed together, end to end, in the order 1, 2, 3, 4, 5, the distance between the extreme ends is the sum of the lengths of the center lines of the yards. The first assumption is only approximately true, and the second is known to be erroneous; but by an amount which it is impossible to measure. Hence the definitive value of the base can only be known after new determinations of the length of the 15-foot standard bar, made with new and more perfect standard yards now in process of construction at the Office of Weights and Measures.

Grading and measurement of base.—The base had been originally cleared by direction of General G. G. Meade, and measured with rods in 1861. It had been hoped to lengthen it somewhat, but this was found impracticable. The old stations at the extremities were standing, and with slight repairs answered the purpose. The surface of the soil at the north end of the base is about 2 feet above the water-level of 1870, and at the south end about 3¼ feet. Between these points the surface undulates as the line crosses from time to time low sand hills, but at no time rises more than 12 or 15 feet above the lake. No trees of any size had grown since 1861, but in some places the bushes were thick, and the clearing away of the sod difficult. Nearly the whole length of the base was on sand or sandy soil, giving a very easy setting for the foot-plates and great steadiness to the tubes. Lieutenant Weeden had charge of the grading of the base-line, which was begun July 14 and finished August 9. Horses with a scraper were used for the heavier work, and shovels by the crew of the surveyor for lighter. The grading was not made wide enough, only 10 feet, and this on embankment, or in cutting, (neither of more than 2 or 3 feet,) forced the tube carriers to go very close (too close) to the standing tube, and frequently required the carriers on the outside of the tube to clamber down the side of the embankment, or up to the top of the cutting, at great risk of falling, or letting the tube fall. The grading where there was cutting or filling or bad bushes or dead trees on the sides ought to have extended 5 feet on one side the base-line and 10 feet on the other, making 15 feet in all. The time required for the grading was very much underestimated. The organization for the measurement was as follows:

1st. General Comstock made and looked after breaking of contacts, read sector, contact level, and thermometer at sector end. Mr. E. J. Knight recording the number of tube and numbers given by General Comstock, and then taking the same readings himself, excepting the contact level, and in addition the thermometer at the middle and forward end of tube. As a tube, after being carried forward, was being placed nearly in position, the sector angle was reread and called out as a check on the preceding reading.

2d. Lieutenant J. H. Weeden, jr., with the base line transit, gave the line, taking it up from the station or pegs previously aligned, about 1,000 feet apart, and putting the front agate of front tube on the line. This line was not strictly correct, once the tubes being off the true line by 3 inches, but as this error was distributed from the offset, (when the error was made in starting in the morning,) over a distance of 800 feet, the resulting error is so small it may be neglected. Hereafter pegs should be very carefully set in a steady atmosphere at distances of 800 feet, then in measuring the base the longest sight of the transit would be 1,000 or 1,100 feet, up to which distance it will work accurately. The instrument should constantly be kept in perfect collimation and level. Lieutenant Weeden was assisted a part of the time by Assistant A. C. Lamson.

3d. Assistant E. S. Wheeler was in charge of placing the trestles, taking from time to time the place of Lieutenant Weeden, or of General Comstock.

The general organization of a base-line party is as follows:

1 assistant to make contacts.
1 assistant at transit.
1 assistant at trestles.
1 recorder.
1 man at forward trestle.
3 men to set foot-plates and level them, (two shovels.)
4 men to carry tubes.
2 men to carry trestles.
2 men to carry foot-plates.
2 men to carry transit.
1 man to carry and place line.
1 man to carry water, and for general duty.
2 men as watchmen.

If party is in tents, there will be needed in addition—

1 cook.
1 steward.
1 waiter.
Total—4 assistants and 21 men.

of June, and proceeded to occupy Wheal Kate Station, ab
O. B. Wheeler and party were landed on the north shore,
12th; and Lieutenant Ruffner and party at Bayfield on th
station at Bayfield had been selected by Captain Farquh
Ruffner's arrival, the station had just been completed
Surveyor, under command of Lieutenant Weeden.

The measurements of the eastern triangle occupied ha
summer of 1869, and on the 21st of June they were compl
ferred to a station on Sawteeth Mountains, (then supp
This station had been selected and built in 1868, and i
was therefore occupied at once, without further exam
further stations, I had received instructions to make the
each shore, that is, to have no consecutive stations which
other; also to avoid triangles containing an angle less th

A thorough reconnaissance was made, every point givin
being carefully examined, and in one instance a station w
miles inland before it could be ascertained that the con
this portion of the lake the outlines of both shores are co
ous, no heights could be found sufficiently prominent
addition to these difficulties, the land is densely wood
tangled undergrowth, rendering progress extremely diffi
discovered a line from Point Detour, near Sand Island, to t
A station was immediately built at the latter place, an
second triangle being completed, Mr. Wisner was moved
August, and five days later Lieutenant Ruffner was trans
impossible to obtain a suitable line west from the sta
another was built on the height one and a half miles furt
was moved August 25. On the 31st of August, Mr. O.
next western station, at Split Rock Point. A station was
Bluffs, west of Detour, at which place, in the felling of tre
dentally killed.

Much time and labor were consumed in endeavoring to
required to connect the triangulation with that of a form
the lake, without definite success.

Owing to severe illness, Mr. O. B. Wheeler was compelled
the 24th of September the remaining work at his statio
corder, Mr. J. C. Jones. It is due to Mr. Jones, as well as
ployed, Mr. J. G. Prout, Clark Olds, and E. F. Cooley, to

nesota Point. The latter part of the season was extremely unfavorable, and it being evident that no further results could be accomplished, on the 10th of October I directed Lieutenant Ruffner to take command of the steamer Surveyor and proceed with his party to Detroit. The remaining parties were taken on board the Search, and arrived in Detroit October 17th, the Surveyor arriving one day later. The party in my immediate command consisted of the officers and crew of steamer Search, save from August 6 to September 7, during which time I was in charge of the steamer Surveyor. I was assisted by Mr. A. C. Lamson, save from July 1 to August 7, and by Mr. E. J. Knight, as recorder, until July 20. As the results of triangulation, observations for latitude, and differences of longitude require reduction in the office, they are not included in this report. I append in tabular form a summary of work performed by parties under my immediate charge.

Very respectfully, your obedient servant,

JARED A. SMITH,
Captain, Corps of Engineers.

Major C. B. COMSTOCK,
Corps of Engineers, in charge of Survey of Northern and Northwestern Lakes.

* * * * * * * * *

OFFICE UNITED STATES LAKE SURVEY,
Detroit, December 10, 1870.

MAJOR: I have the honor to submit the following report of operations of the party under my charge during the past season.

The appropriation for the Lake Survey having passed both Houses of Congress on July 15th, the steamer Ada, in obedience to your instructions, was fitted out for service in the field, and left Detroit on July 28, having on board in addition to my own party two shore parties, under charge of Lieutenant Livermore and Assistant J. R. Mayer. Lieutenant Livermore's party was landed at Benona, on the east shore of Lake Michigan, during the afternoon of July 31, and Mr. Mayer's party the day following on the west shore, a mile or two below the town of Manitowoc, Wisconsin.

To the party under my charge (consisting of Assistants Lewis Foote, W. T. Emerson, and Recorder R. Wallace) was intrusted the continuation of the off-shore hydrography on the east and west shores of Lake Michigan, and in addition the moving and supplying the shore parties with provisions. I was also ordered, if my other duties would permit, to run some additional lines of soundings at the north end of the lake, between Farnsworth's Point and Point Aux Chenes, and also between Beaver Island and the east shore.

Work on the west side of the lake was begun at Dean's Dock and continued south as far as the shore party work would permit, viz, sixteen miles south of Sheboygan, making about forty-five miles on this side of the lake.

On the east shore but little was done, owing to bad weather in the month of August, which prevented the shore party from sounding, and also on account of the removal of that party to Lake Champlain early in September. The work on this shore was begun at Little Point Sable, and continued south about twelve miles.

On the completion of this work on the east shore, I proceeded with the steamer to Seul Choix Point, on the north shore. I found the station at that place still standing but very much in need of repairs. The station on Point Patterson was in a worse condition and could not be used for sounding without cutting a great deal of timber between it and the lake. I was obliged, therefore, for want of time, to use the station on Farnsworth Point in connection with the one at Seul Choix. The stations on High and Gull Islands were also used for running lines between them and the north shore.

Our provisions and coal getting low, and being obliged to meet you in Milwaukee on the 29th of September, I left the north shore on the evening of the 23d for Milwaukee, intending to run several long lines of soundings across the lake on our way south. Three of these lines were finished; one from south end of Poverty Island to south end of South Fox; one from Pilot Island Light to south end of North Manitou, and the other from Manistee Piers to a point on west shore, a few miles above Two Rivers.

The high winds during October almost entirely prevented us from sounding, as our remaining work consisted of long lines to be run across the lake, and for this calm weather is absolutely necessary. From the 1st to the 20th of October inclusive, we had but four days on which it was possible to sound.

On October 19 I received instructions from you to bring my own and Mr. Mayer's parties to Detroit, provided the latter could not work to advantage during the remainder of the month. I was also instructed to stop on the way down and try to find a reef that was reported off Biddle Point, on north shore. Learning from Mr. Mayer that a few days more would be all that were necessary to finish the work at his camp, I concluded to leave him to come to Detroit on one of the regular passage boats. I left Sheboygan on the 20th of October for Biddle Point. I found a bad reef, with only 8 feet of water on shoalest part, about four miles south of Mille Coquin Point,

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MAJOR: I have the honor to submit the following
performed by the party under my charge in the field du
1st. The party consisted of Civil Assistants E. S. Whe
John Whiting, and twenty-five men, in which number
seamen of the steamer Surveyor.

2d. Leaving Detroit at sunrise on the morning of tl
for Lake Superior and arrived at Porcupine Mountains a
7, where I landed an astronomical party, consisting of
Cooley, and four men.

June 8.—Ran to Bayfield, Lower Canada, where I built
tion, with a 40-foot center-post, completing the same on

June 15.—Ran out to the Apostle Islands and comme
line of certain of the unsurveyed islands, together with
the same, upon which the party was employed until We
time a complete survey was made of Ironwood, Great
Devil Islands, with *all* of their soundings, a partial su
Island, with *all* of its soundings, and the soundings of S
plete in 1869.

July 14.—Having taken on board the base-line appar
rior City, Wisconsin, to make arrangements for measurin
Point. These arrangements, consisting of comparing th
15-foot rod and grading the line, were completed on the
6, 1870, at which time I, by your order, ran to Bayfiel
Surveyor over to Major Smith, Engineers, assuming com

July 21.—Recorder Knight transferred from Major Smi
replace Recorder Whiting, who returned home on accoun

July 24.—Assistant Lamson was transferred to replace
reason. During this time there was a great deal of sick
from two causes. Firstly, the season was unusually u
Lake Superior, from Bayfield, Wisconsin, to Duluth, M
interior arrangements of the steamer were such as to cau
cause not obtained. Recorder Whiting died of typhoid fe
I am assured by his attending physician that there was a
symptoms up to the time of his leaving my party.

August 8.—I returned to Minnesota Point on this date
party now under my charge consisting of

STEAMER SURVEYOR,
Off Port Sheldon, Michigan, September 20, 1871.

MAJOR: I have the honor to make the following report of the work performed in the northern part of Lake Michigan by the steamer and party under my orders:

I left Detroit on the 20th of May last in command of the chartered propeller D. W. Powers. My instructions were in general terms to complete the hydrography in the northern part of the lake, as far south as lines drawn from the south end of Beaver Island, east and northwest, to the mainland, and also to run lines of deep-sea soundings, where needed to complete the series, at the distance of ten miles between the lines, in the northern half of the lake.

I proceeded to the straits of Mackinac, and while waiting for the sounding apparatus and leads, which were not ready at the time of my departure from Detroit, I made a reconnaissance of the shore-line, and commenced building stations.

The sounding-reel having been received and fixed in place on the night of May 30, the off-shore hydrography was commenced the following morning. The first line was run in the straits of Mackinac, and opposite McGulpin's Point light-house. From thence the sounding was carried westward, following both shores, until connection was made with Lieutenant A. N. Lee's work of the previous season. The last line run was two miles west of Scott's Point. The open spaces between Beaver Island and the east shore, Beaver Island and Gull Island Reef, and between High and Gull Islands, were also filled in. The lines of soundings are approximately one mile apart, and in general direction perpendicular to the axis of the lake. The soundings in each line were made one-quarter of a mile apart where there was reason to suppose that dangers to navigation existed; one-half a mile where the bottom was regular and the depth of water less than 20 fathoms, and one mile apart in deeper water.

If the former case, cross-lines of soundings were run one-half a mile apart. Two thousand and seventeen casts of the lead were made, 78 per cent. of which were located instrumentally.

The work was plotted as it progressed. Thirteen stations were built with center-posts, averaging 12 feet in height; four primary triangulation stations were repaired, and two light-houses occupied as stations.

But few of the stations of the secondary triangulation could be identified, and cuts through woods, for lines of sight, had almost disappeared. I was thus obliged to use stations with long lines between them, and from which the point of reference in the horizontal angles was sometimes on a side opposite from the other station. It was not considered profitable to spend the best part of the season in reconnoitering for, building, and locating stations at more convenient distances.

A reef not before located was discovered. It is seven miles south of Mille Coquins, and in range with Potter's Reef and Patterson Point. It bears 11 feet of water. A spur of the reef, with 14 feet of water on it, lies southeast, and one and one-half miles distant.

Rocks, sometimes above water, were found one-quarter of a mile from the mouth of Rocky Run, a small stream which flows into the lake midway between Mille Coquins and Cranberry Point. There is a channel inside the rocks for coasters. A spur of the shoal which projects eastwardly from Mille Coquins Island, not indicated on the published chart, was sounded and located.

A shallow spot, bearing 8 feet of water, was found S. E. by S. from Waugoshance light-house, and midway to Waugoshance Island. The chart indicates 15 and 18 feet of water.

From my own observations, and the statements of fishermen living near by, it is believed that the channel between the light-house and the island is subject to constant change. A strong current sometimes sets through the narrow passage, and the force of a heavy sea in the shallow water, and of the ice, piles up at one time and place, and at another spreads out the small boulders with which the bottom is covered. Steam-vessels almost invariably pass outside the light-house, keeping about one-half a mile distant, and masters of sail-vessels only attempt the inner passage with a favorable wind and current.

I would respectfully suggest that the sailing courses, as laid down on the published charts, may be changed accordingly.

Seven hundred and eighty-eight soundings were made from the small boat, and four stations built.

Every opportunity was taken to gain information about dangers to navigation. It is thought that the only reef not indicated on the chart is the one off Mille Coquins.

A line of deep-sea sounding was made W. by N. ¼ N. on Rock Island light-house, and one E. by S. ¾ S. on the northern point of the North Fox Island. This completed the series of deep-sea soundings in the northern part of the lake. Forty-eight casts of the lead were made.

The hydrography was completed on the 5th of August.

Some difficulty was met with on account of the inexperience of the party and delay created by breakages, at two different times, in the steamer's engine.

Very respectfully, your obedient servant,

CHAS. F. POWELL,
Second Lieutenant Engineers.

Major C. B. COMSTOCK,
In charge of U. S. Survey of N. and N. W. Lakes.

Appendix C.

REPORT OF FIELD OPERATIONS PERFORMED DURING THE SEASON OF 1871 BY THE SHORE PARTY IN CHARGE OF HENRY CUSTER, ASSISTANT UNITED STATES LAKE SURVEY.

The shore party under my charge was organized on the 11th of May, 1871, and arrived at the place of destination on the 19th of May. The first camp was located on the Kalamazoo River, about half a mile above its mouth. Here the labors of the party were to begin, and for the present, or immediately, to consist of a survey of a section of shore-line, and of the Kalamazoo River from its mouth upward for a certain distance.

The field-work performed by the party may be properly classified in three classes, namely:

1. Survey of the shore-line and determination of azimuths.
2. Sounding.
3. Topographical work.

I.—SURVEY OF SHORE-LINE.

The survey of the shore-line was begun at a point about one and a half miles distant, northward from the mouth of the Kalamazoo River, continued from the first camp to a point some 10.5 miles south from the point of beginning.

The locality at the southern end of section I is marked by the remains of an old pier, and is otherwise about 4.5 miles southward of the village of Piercore, situated upon the shore of the lake. Two kinds of signals or stations were used for this survey—one designated as sounding stations, the other as shore or chaining stations.

The sounding stations consisted of poles 8 to 10 feet high, sunk into the ground, on which the numbers of the station were nailed, the whole properly whitewashed and braced. These stations were set as near as could be done from 700 to 800 meters. Shore stations or chaining stations were built in such a way that they could be occupied by a theodolite. They consisted of a post sunk in the ground, about 4 feet high above ground with a hole in the center into which a staff could be inserted, the whole station properly whitewashed. Owing to the convexity of some portions of the shore-line of section I these shore stations had to be set at short distances from each other, to enable sight and chaining from one to the other. Where the shore-line was concave, longer distances were kept between the stations; as a general thing it was not found desirable that they should exceed the length of 700 to 800 meters, as longer distances could not be well determined by the stadia.

Over the whole distance of 10.5 miles of section I, 25 sounding stations and 39 shore stations were set. At the southern extremity of this section an azimuth or tripod station was erected, some 20 feet high, from which a point on the northern end could be seen, (leaning tree.) These azimuth stations were set at convenient points all along the shore-line surveyed by the party, the first one on azimuth station No. 1, at a point already described; the second on azimuth station 2, at Camp II, near South Haven; the third on azimuth station III, 12.5 miles south of South Haven; the fourth on azimuth station IV, at the mouth of St. Joseph's River; the fifth on azimuth station V, near a locality called Grand Marais; the sixth on azimuth station VI, at Camp 4, near New Buffalo. All these stations, excepting No. 5, were occupied, and the angle formed by the stations north and south, with the one occupied, carefully determined, thus gaining valuable data for a meander of the shore-line at large, which would check any error of the subsequent detailed shore-line meander in distance as well as azimuth.

On each of these azimuth stations, careful observations for azimuth were taken, (no observations were made at azimuth station V,) generally on Polaris, the two sets of observations agreeing always, within the limits of a number of seconds. In this manner the azimuth of the same line was obtained twice, the difference in the two results being the amount of convergency of the meridians for their respective difference in the longitude. With latitudes obtained with only moderate accuracy, the difference of the two respective azimuths of the same line would give a fair means to determine its length.

The distances between the shore signals were determined by a chain 20 meters (more or less) long, and also by readings of the stadia, more with a view to detect any considerable error in the chaining than with an expectation that the results of both should closely agree.

In section I, shore-line survey, the chaining had to be made over very rough ground, strewn with logs and drift-wood, interfering materially with the accuracy of the measurement. It is next to impossible to control the error made in such chainments, except by giving, where the ground was very rough and the distance not too long, preference to the distances obtained by the stadia. Measurement over lines adjacent to the ones going over very rough grounds could often not be obtained, or would show such a variety of results, out of which no general rule for similar cases could be obtained; that is to say, the application of a correction coefficient for distances chained over very rough ground was generally so uncertain as to make its use doubtful. Additional shots or bearings to buoys previously well determined will detect larger errors in the chaining, while small ones must necessarily remain undetected. There is, therefore, in each of the distances a probable error which cannot be detected.

The angles between the shore-stations were determined with theodolite 184. The instrument was placed on a trivet, which had been previously inserted accurately over the center of the station. The angles were read with care, and by taking care to shade the level (stride level) from the sun's rays good results were obtained. Generally the magnetic azimuth was carried on; the instrument being provided with a sensitive needle, it gave the observer a ready means to detect at once any larger errors in the reading of the angles. Some of these meander lines (3) were computed, that is to say, their latitude and departure ascertained, and with it their respective closure.

The results obtained were as follows:

1st section, closure 20′; [*] 2d section, 9.3 miles long, closure 5′; 3d section, 12.5 long, closure 4′.

The considerable discrepancy in the closure of the first section (10.5 miles long) is probably due to the roughness of the ground which had to be chained over, to the comparatively short distance between the shore-stations, but probably principally to the fact that during this survey the instrument's level had not been shaded, causing a frequent change in the level and the axes of the telescope.

The second section of shore-line, some 9.3 miles long, lies between Azimuth Station I and Azimuth Station II. The survey and chaining were performed as above described, the instrument however shaded. The chaining was much better on this section than on the previous one. The shore-line being concave, bending westward, longer distances could be made between the shore-stations. The azimuth of the line Azimuth Station I and Azimuth Station II was determined on both stations, (1 and 2,) and the results agree closely if proper allowance is made for their difference in longitude, which amounts to 2,500 meters. Over this section, 42 shore-stations and 25 sounding-stations were erected. Section 3 of shore-line lies between Azimuth Station II and Azimuth Station III. Its measured length is a fraction more than 12.5 miles. The survey of this section was conducted in a similar manner as on the former sections. The chaining was good, and the distances between the shore-stations, on an average, about 500 to 600 meters long. The azimuth of the line Azimuth Station II and Azimuth Station III was obtained on both ends. The results vary about 5′, giving for the difference in longitude about 7,500 meters, which agrees very nearly with the one computed from the meander[†] itself. These computations are necessarily only approximate ones, since the azimuth computations are only approximate; also the amount of convergency due to a certain difference in longitude was only approximately obtained. On this section 46 shore-stations and 30 sounding-stations were erected. The next section, section III, brings the survey as far as the mouth of St. Joseph's River. Here a station, erected by Lieutenant Weeden, United States Engineers, of the steamer Surveyor, was used for an azimuth station. The length of the shore-line between Azimuth Station III and Azimuth Station IV is 9.5. The chaining over this section was good, and the distances between the shore-stations average 500 to 600 meters.

Over this section were located 21 sounding-stations and 26 shore-stations. The next section of some ten miles brings us to Azimuth Station V, near the locality known as Grand Marais. On this section the chaining was also favorable. Both sections IV and V have, owing to want of time, neither been plotted nor computed. The closure of their respective meanders can, however, confidently be assumed to be very close, since the survey was made under very favorable circumstances. Over section V, 22 sounding-stations and 26 shore-signals were located. No observations of any kind have as yet been made at Azimuth Station V, and the shore-line of section 6, about sixteen miles long, not as yet surveyed.

Uncommon sickness among the working force of my party delayed and crippled my operations in St. Joseph in such a manner that plans for operations further southward had to be changed entirely.

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[*] Entirely too large, and should be corrected.

[†] 7,420$^{\mathrm{m}}$ difference in longitude computed from the meander of the section.

The location of camp No. 4 to New Buffalo was made urgent by the sickness of the men, which made nearness to medical aid absolutely desirable. Since our location in camp No. 4, additional sounding-stations and shore-stations have been set; first, on section 7, about nine miles in length, 20 sounding-stations and 27 shore-stations were erected. On section 6, northward, only 10 sounding-stations and 12 shore-stations have as yet been located.

The azimuth of the line Azimuth Station V and Azimuth Station VI has been determined once, namely, at Azimuth Station VI, also that of the line or direction from Azimuth Station IV to the light-house of Michigan City. A strong attempt will be made by the party under my charge to finish the work from Grand Marais to Michigan City, and, if the weather and the health of the men permit of it, it will be probably successful.

Summing up the labors performed on shore-line surveys, up to date, we obtain the following results:

Total number of miles of shore-line survey	52
Total number of stations located	151
Total number of shore-stations erected	219
Number of azimuth-stations erected	6
Total number of angles read to determine the location of shore and sounding stations	300
Number of computations made to determine the latitude and longitude of the respective shore-line meanders of section 1, section 2, and section 3	258
Number of miles of shore-lines plotted	32.5

DETERMINATION OF AZIMUTHS.

Azimuths were determined both by observations on the sun, but principally by observations on Polaris. The former were made with theodolite No. 104, the latter with instrument 69. This instrument has its axes unpierced, and consequently, for observing, the light had to be thrown in in front, a method of observing on stars entirely new to the observer. On Azimuth Station I observations on the sun were made.

Of a series of six observations obtained on the sun by theodolite No. 104, with a vertical circle reading to minutes, the mean azimuth of 12° 32′ 08″ was obtained for the line Azimuth Station I and Azimuth Station II.

The azimuth observations on Azimuth Station II were made on Polaris, with correct time; some before elongation, others after it. The result of these observations were reduced to true elongation time.

Result of six sets of observations, three repetitions each set, with direct and reversed telescope, give for the azimuth of the mark, the angle 35° 24′ 04″, (first night.)

Result of seven sets of similar observations give the angle 35° 24′ 18″, (second night.)

This shows, in the results of the two nights, a difference of 14″. This result may vary slightly where the final computations are made.

The azimuth of line Azimuth Station I and Azimuth Station II, obtained from these observations, is 12° 33′ 24″. Azimuth of the same line, obtained from observations on the sun, 12° 32′ 08″; difference in azimuth, 1° 16″. Difference in longitude between the two stations is 2,500 meters, or producing a convergency of meridians of about 1′ 27″, a result not differing much from the difference in the two azimuths.

On Azimuth Station III the mean azimuth of the mark obtained from eight sets of observations of three repetitions each, direct and reversed telescope, is 42° 52′ 47″, (first night.)

Azimuth of mark obtained from six similar sets of observations is 42° 52′ 57″, (second night.) Difference between the results of the two nights' observations, 10″.

Azimuth of line Azimuth Station II and Azimuth Station III, obtained at Azimuth Station II, is 21° 20′ 47″.

Azimuth of same line obtained at Azimuth Station III, 21° 15′ 43″.

Convergency of meridians, 5′ 3″ in 12.66 miles of shore-line.

Observations for azimuth, made at Azimuth Station IV, at St. Joseph, give the following results:

Azimuth of mark obtained from two sets of observations is 58° 56′ 18″.

Second night, azimuth of mark obtained from three sets of observations is 58° 55′ 42″.

Mean azimuth obtained from two nights' observations, 58° 56′ 00″.

Azimuth of line Azimuth Station III and Azimuth Station IV, at Azimuth Station III, is 35° 53′ 56″.

Azimuth of same line obtained at Azimuth Station IV, is 35° 50′ 04″.

Convergency of meridians, 3′ 52″ in nine miles of shore-line.

Azimuth of line Azimuth Station IV and Azimuth Station V, obtained from the observation on Azimuth Station IV, gives the angle 8° 18′ 38″.

All these observations may vary when the final computations are made, using a correct latitude instead of only an approximate one. The result of the second night's observations may also modify itself, since, being taken near elongation time, no reductions to the true time were made, but simply the mean of all adopted.

As an example how observations on Polaris were generally made, and how they run, I will here add a set of observations made at Azimuth Station VI, New Buffalo.

August 10.—Time of east elongation of Polaris, 7h. 35m. 16s., mean time. Watch slow, 11′ 46″. Azimuth of Polaris, 1° 51′ 07″, for the approximate latitude of 41° 48′ 03″.

Result of first set of observations of three repetitions, angle between Polaris and mark, 119° 52′ 58″; time, 7h. 33m. 53s.

Result of second set of observations of three repetitions, angle between Polaris and mark, 119° 52′ 05″; time, 7h. 44m. 50s.

Result of third set of observations of three repetitions, angle between Polaris and mark, 119° 52′ 28″; time, 7h. 58m. 51s.

Result of fourth set of observations (reversed telescope) of three repetitions, angle between Polaris and mark, 119° 53′ 03″; time, 8h. 12m. 50s.

Result of fifth set of observations of three repetitions, angle between star and mark, 119° 53′ 50″; time, 8h. 25m. 32s.

These observations will give the azimuth of two lines, namely, of line Azimuth Station V and Azimuth Station VI, and of the line Azimuth Station VI and Michigan City light-house.

Finally, I add here the angles obtained at the different azimuth stations between two other stations north and south of it:

Azimuth Station I.—Leaning tree, (point northward,) Azimuth Station II, South Haven: angle, 172° 28′ 45″.

Azimuth Station II.—Azimuth Station III and Azimuth Station I: angle, 171° 12′ 24″.

Azimuth Station III.—Azimuth Station IV and Azimuth Station II: angle, 165° 21′ 38″.

Azimuth Station IV.—Azimuth Station V and Azimuth Station III: angle, 191° 28′ 31″.

Azimuth Station V.—No observations of any kind made as yet on this station.

Azimuth Station VI.—Azimuth Station V and Michigan City light-house: angle, 159° 11′ 36″.

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II.—SOUNDING.

In connection with the survey of the shore-line, a series of soundings were made from buoys located some distance from shore, to the sounding-stations, and from them back to the buoys. The construction of these buoys was the one usually adopted by the Lake Survey. They were anchored, for the first few miles from Azimuth Station I, northward in 4 fathoms of water; afterward, during the whole survey, in 4½, 5, and 5½ fathoms of water; in fact, in such a manner that their distance from shore would exceed rather than fall short of one-half a mile. They were also placed as near as possible opposite the corresponding sounding-stations on shore, and numbered in accordance with those.

The number set over the fifty-two miles of shore-line, as yet surveyed, was 121; to that number must be added 20 more, recently set from New Buffalo to Michigan City, which will bring up the total number of buoys set to 141. Of this number 121 have been each determined by 4 angles or bearings at least.

* * * * * * * *

River-soundings were taken in the Kalamazoo River and in the Black River, South Haven. In the former four additional buoys were set, some distance outside of its mouth, in 5 fathoms of water, from which four parallel (or nearly so) ranges were sounded to some points up the river, the soundings were 15-second soundings. The rest of the soundings on this river were made over 25 stations, located on both banks of the river. Station 25 was located at the point which may be assumed the head of navigation of the river, some two and a half miles distant from its mouth.

* * * * * * * *

The Black River is too narrow a stream to admit of much sounding. Here one buoy was set outside the river's mouth in 5 fathoms of water, and from it a range of soundings taken to a point up stream; thence, sounding through the middle of the stream, and along both of its banks, (10′ from it,) to a pointconsidered the head of navigation.

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III.—TOPOGRAPHY.

This branch of the work performed by the party under my charge was, perhaps, more fully developed than is usually the case with shore parties, and consequently, also, probably more time has been spent upon its development.

The topographical work performed by the party may properly be divided in three classes:

1. Triangulation.
2. Plane-table work.
3. Topography surveyed by theodolite.

Of each class or branch I shall take the liberty to make a few remarks:

I. *Triangulation.*—Triangulations were principally made to locate inland points, defining the locality of rivers, towns, or villages.

The first triangulation was made on Kalamazoo River, and extending itself from two to two and a half miles up-stream, defining the locality of the river, and of the villages Saugatuck and Douglass. * * * *

The following data will show the correctness of the work:

Base-line A measured 216^{m}, 215.5 computation;

Base-line B measured 179.3; 179.6 computation.

Line from northwest signal to Dock street: 1. Computation, $1148^{m}.9$; 2. Compnation, + 1148.2.

Line from Dock street to Bluff street: 1. Computation, 794.07; 2. Computation, 7[illegible].97.

Line from Forrest street to Northwest street: 1. Computation, 769.24; 2. Computation, 769.05.

The closure of the respective triangles was within the limit of the reading of the theodolite 104, with which the triangulation was made.

The second triangulation was made at South Haven, and consisted of the definition of the sides and angles of one triangle, which, in its turn, defined in a general way the river and the town of South Haven. * * * * *

1. Measurement of a broken base-line.
2. Erection of four signals.
3. Occupation, four stations, determination of twelves angles by two sets of three, repeating each.
4. Computation of seven distances, two of which were check-computations, locating the five points of triangulation. * * * * *

II. *Plane-table work.*—This instrument, I believe newly introduced into the service of the Lake Survey, recommends itself for use where the topography is very dense and variegated, and the topographical features are grouped square-like, or nearly so.

When guide-points obtained by triangulation form the base of plane-table work, a degree of satisfactory accuracy may be obtained with this instrument. Our labors in this branch of topography amount to three plane-table sheets, comprising an area of 12.5 square miles of dense and minute topography.

First sheet contains a minute survey of Kalamazoo River; also, of the villages Saugatuck and Douglass. This sheet contains six square miles of topography.

* * * * * * *

Second sheet comprises the town of South Haven and suburbs; also, Black River for about two and a half miles from its mouth up stream. It embraces an area of two square miles of topography. * * * * *

Third sheet.—This sheet embraces an area of variegated topography amounting to 4.5 square miles. Its principal features are a survey of the towns of Benton and St. Joseph; also, a survey of the St. Joseph and Paw Paw Rivers for a distance of from two to two and a half miles up stream from their mouths.

The fourth sheet, if finished this season, will comprise New Buffalo town. * * *

III. *Topography obtained by the use of the theodolite.*—This comprises all the topography outside or further removed from villages or towns. Generally, a leading road, or leading roads, were selected to obtain the topography in the vicinity of the lake shore. Instrument 104, having a magnetic needle, was selected for this purpose; the points were determined by a reading of the stadia and a compass bearing. Care was taken to connect the inland survey as often as possible with the shore-line survey, so as to prevent any difficulty in the closure of these two surveys.

It may be fairly assumed that as far south as St. Joseph, the topography to the extent of a mile* was included in the survey, thus forming a belt of country about thirty-eight to thirty-nine miles long and a mile wide, topographically surveyed.

The topography taken from St. Joseph southward extended itself only over about one-half a mile back from the shore-line. * * * *

An important feature of the topographical survey was to obtain the real or approximate height of the points surveyed. As a general thing, it may well be assumed that the rise and fall of the country adjacent to the lake shore corresponded nearly with the change of height of the bluffs on the shore itself. To obtain the heights of these bluffs on the lake shore, measurements were made, either by the hand-level and chain or with the instrument 104 and a stadia. * * * In the vicinity of

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* One mile back from the lake shore.

Saugatuck, where the terrain is very hilly and wooded, a number of cross-sections were made to define the height and location of points. * * *

The above report comprises all the field operations performed by the party under my charge. The distressing spread of sickness among the working force of the party has crippled our labors, or their extent, materially already last month; the same is the case in our new camp, many cases of fever that appeared to do better in our new camp have now again relapsed.

Since this report was begun, both of my assitants have fallen sick; one of them has left the survey and gone home. My health is far from being good; relapses of the fever have reduced the stability of my health. Under these circumstances, very little labor can be expected from the party, and probably a great deal of the work on this section will be left undone. Conclusively, I cannot omit that I have been creditably assisted by Messrs. McLean and Houseman. The two did all the sounding, and during the whole season the former was in charge, for various purposes, of a working force, while the latter generally assisted in topographical work and computing.

I have the honor to be, very respectfully and truly, yours,

H. CUSTER,
Assistant United States Lake Survey, in charge of party.

Appendix D.

OFFICE UNITED STATES LAKE SURVEY,
May 15, 1871.

MAJOR: I have the honor to submit the following report of the determination of the constants, of the primary base apparatus used on the United States Lake Survey.

The thermometers used were compared with the Wurdemann standard thermometer in this office.

The method of comparison was as follows: The standard thermometer and those to be compared were all suspended in a glass receiver, which was clear enough so that they could be read from the outside. The receiver was then filled with pounded ice, covered with a wooden cover, and provided with a dasher so that the ice could be stirred about as it melted. In this condition all the thermometers were read several times. Afterward the receiver was filled with warm water, and all the thermometers were read at several different temperatures. The mean results are tabulated below.

Thermometer No. 1 of the base apparatus was broken at the close of the measurement of the Minnesota base-line; hence it could not be compared as the others were, but a very close approximation to its error from the thermometer readings made last season. No. 1 then stood near No. 2.

After correcting all the other thermometers, the true temperature of the place in which No. 1 stood could be estimated very nearly; then this subtracted from the reading of No. 1 gave its error very nearly for that temperature.

Table of corrections for thermometers.

	STANDARD.									
	At 32°	At 41°	At 50°	At 57°	At 70°	At 75°	At 88°	At 96°	At 101°	At 110°
Troughton & Simms' standard.	0.00	....	....	—0.10	....	....	—0.65	—0.74	....	....
No. 10, (base)........	—0.84	....	....	—0.77	—0.80	....	—1.23	—1.00	....	....
No. 2, (base)........	—0.75	....	....	—1.20	—1.64	....	—1.90	—2.15	....	....
No. 3, (base)........	—1.30	....	....	—1.57	—1.73	....	—2.20	—2.40	....	....
No. 4, (base)........	—1.04	....	....	—1.27	—1.25	....	—1.80	—1.70	....	....
No. 5, (base, new)...	—0.16	....	....	—0.03	....	....	—0.00	—0.10	....	....
No. 6, (base)........	—0.11	....	....	—0.53	—0.66	....	—1.20	—1.15	....	....
No. 1, (broken).....	....	....	....	....	—1.60	....	....	....	....	....
No. 1422 A..........	—0.81	....	....	—0.57	....	....	—0.80	—1.10	....	....
No. 1459 B..........	—1.13	....	....	—1.17	....	....	—1.20	—1.30	....	....
No. 1464 A..........	—0.61	....	....	—1.00	....	....	—0.80	—1.90	....	....
No. 2071 A..........	—0.71	....	....	—0.73	....	....	—0.73	—0.70	....	....
No. 2072 A..........	—0.40	....	....	—0.67	....	....	—0.27	—0.45	....	....
No. 1460 A..........	....	—1.14	—1.11	....	....	—1.20	—1.20	—1.24	—1.25	—1.32
No. 1478 A..........	....	—0.74	—0.80	....	....	—0.63	—0.65	—0.64	—0.65	—0.73
No. 1478 B..........	....	—0.61	—0.64	....	....	—0.66	—0.60	—0.47	—0.80	—0.68
No. 1493 B..........	....	—2.24	—2.14	....	....	—2.10	—2.10	—2.21	—2.25	—2.20
No. 1446............	....	—0.81	—0.80	....	....	—0.80	—1.00	—1.01	—1.15	—0.92

All the thermometer readings were corrected by the above table.

The value of the divisions of the Baumann comparator No. 1 (Coast Survey) were determined by comparing them with the standard inch-scale in this office. This scale is of silver, one inch long, and divided into tenths on both sides. The gradations on one side are much heavier than those on the other side. The two sides are therefore distinguished as the heavy and fine sides. The following table shows the value of each division as given by J. E. Hilgard.

Table showing the value of each division of silver scale.

Heavy side.		Fine side.	
0 to 1	.10001 inch.	0 to 1	.10038 inch.
1 to 2	.10066 inch.	1 to 2	.10031 inch.
2 to 3	.10001 inch.	2 to 3	.09944 inch.
3 to 4	.09961 inch.	3 to 4	.10021 inch.
4 to 5	.10028 inch.	4 to 5	.10036 inch.
5 to 6	.09998 inch.	5 to 6	.09974 inch.
6 to 7	.09986 inch.	6 to 7	.09978 inch.
7 to 8	.10026 inch.	7 to 8	.09988 inch.
8 to 9	.10023 inch.	8 to 9	.10000 inch.
9 to 10	.09969 inch.	9 to 10	.10035 inch.
	1.00059 inch.		1.00045 inch.

The method of comparison was as follows: The comparator was firmly fastened on the top of a stone post. The silver scale was laid on the comparator with its edge parallel to the axis of motion. A microscope was mounted above the scale, with its cross-hairs bisecting a graduation of the scale. In this position the comparator was read. The micrometer of the comparator was then turned, carrying the scale with it, until the cross-hairs bisected another gradation of scale, when the comparator was read a second time. The value of the division of the scale, over which the cross-hairs passed, was then divided by the difference of the two comparator readings. The result was the coefficient required to reduce the comparator readings to American inches. This coefficient was determined for each tenth of the comparator.

Each tenth of the comparator was tested on six different divisions of the silver scale. The mean results are tabulated below.

Table showing the ratio of each tenth of the screw of Baumann comparator, No.* 1, *to an American inch, as determined from the standard inch scale.

HEAVY SIDE.

On micrometer screw, from 0 to 1 ratio	=1.0880
On micrometer screw, from 1 to 2 ratio	=1.0857
On micrometer screw, from 2 to 3 ratio	=1.0873
On micrometer screw, from 3 to 4 ratio	=1.0854
On micrometer screw, from 4 to 5 ratio	=1.0855
On micrometer screw, from 5 to 6 ratio	=1.0860
On micrometer screw, from 6 to 7 ratio	=1.0897
On micrometer screw, from 7 to 8 ratio	=1.0934
Mean	=1.0877

FINE SIDE.

On micrometer screw, from 0 to 1 ratio	=1.0885
On micrometer screw, from 1 to 2 ratio	=1.0869
On micrometer screw, from 2 to 3 ratio	=1.0879
On micrometer screw, from 3 to 4 ratio	=1.0871
On micrometer screw, from 4 to 5 ratio	=1.0893
On micrometer screw, from 5 to 6 ratio	=1.0883
On micrometer screw, from 6 to 7 ratio	=1.0859
On micrometer screw, from 7 to 8 ratio	=1.0877
Mean	=1.0877

MEAN OF BOTH SIDES.

On micrometer screw, from 0 to 1 ratio	=1.0883
On micrometer screw, from 1 to 2 ratio	=1.0863
On micrometer screw, from 2 to 3 ratio	=1.0879

On micrometer screw, from 3 to 4 ratio .... =1.0862
On micrometer screw, from 4 to 5 ratio .... =1.0874
On micrometer screw, from 5 to 6 ratio .... =1.0874
On micrometer screw, from 6 to 7 ratio .... =1.0878
On micrometer screw, from 7 to 8 ratio .... =1.0905

Mean .... =1.0877

Since the readings have always been taken between the second and sixth tenths, the mean of the four middle spaces = 1.0872 has been adopted for use in all the following reductions. The microscopes used in these comparisons were from one of the Dertling theodolites, and had a magnifying power of 36 diameters.

The Wurdemann comparator No. 1, (Lake Survey,) was compared with the Baumann comparator No. 1 in the following manner: Both were placed on a stone post, end to end, with their axis of motion parallel. The quills of the Baumann comparator butting against the end of the level of the Wurdemann comparator. The space between 6 and 7 of the Baumann comparator was taken for a standard, and compared with the space approximately between 0 and 1, 1 and 2, 2 and 3, 3 and 4, &c., of the Wurdemann comparator. The mean results are tabulated below:

TABLE.

Space between 6 and 7 on the Baumann comparator, when measured approximately between—

0 and 1 on Wurdemann comparator .... =10916
1 and 2 on Wurdemann comparator .... =10892
2 and 3 on Wurdemann comparator .... =10875
3 and 4 on Wurdemann comparator .... =10861
4 and 5 on Wurdemann comparator .... =10847
5 and 6 on Wurdemann comparator .... =10836
6 and 7 on Wurdemann comparator .... =10755

Mean .... =10855

Hence the mean ratio of the space between 6 and 7 on the Baumann comparator to the Wurdemann is 10855, but the ratio of the space between 6 and 7 to a United States inch is (from a preceding table) 10878, dividing the latter by the former, the result is 1.0021, which is the co-efficient by which the readings of the Wurdemann comparator should be multiplied to reduce them to United States inches.

The standard yards Nos. 1, 2, 3, and 4 were compared with No. 5, which is marked an exact yard. The method of comparison was as follows: A beam of wood 4 feet long was fastened to the top of a stone post and carefully leveled. The two comparators were then secured to this beam at a distance of one yard from each other. A board 18 inches long, with three leveling-screws resting on glass slides lay between the comparators, and supported the yards. This board could be moved sidewise, so as to bring first one yard and then the other between the quills of the comparators. It was also provided with a tangent screw for slow longitudinal motion. Yard 5 was first brought between the comparators, and the quills carefully centered on its end. It was then moved longitudinally until both ends of the bubble in the Wurdemann comparator were visible.

The Baumann comparator was then read, and the bubble only of the Wurdemann comparator. The same process was repeated upon another yard, the difference in the reduced readings being the difference in the length of the yards. The mean of all the observations are tabulated below.

Table showing the relative lengths of the standard yards.

Yard No. 1 shorter than yard No 5	.00016	United States inches.
Yard No. 2 shorter than yard No. 5	.00016	United States inches.
Yard No. 3 shorter than yard No. 5	.00040	United States inches.
Yard No. 4 shorter than yard No. 5	.00038	United States inches.
	.00110	

If yard 5 be considered an exact yard, then the total length of the five yards is 179.99890 American inches. This value is for the central lines of the yards.

The expansion of the brass standard bar 15 feet long for 1° of temperature, Fahrenheit, was determined in two ways: In the first way the bar was placed between two comparators, which were mounted on stone piers, fifteen feet apart. The bar was centered and read in the manner previously described for the yards, first at a low temperature, and then at a high temperature. The difference in the two readings divided by the difference in temperature gives the expansion for one degree.

The temperature was determined by placing six thermometers in contact with the bar, and reading them each time the comparator was read. They were then corrected by the first table, and their mean taken. This method has been adopted in all the following experiments where temperature has been required.

The mean results corrected for thermometer errors, and reduced to American inches, are tabulated below:

Table of results showing the expansion of standard bar and comparators for one degree of temperature, Fahrenheit.

Date of observation.	Difference between high and low temperature.	Expansion for one degree.
	Degrees.	*Inches.*
December 27 and 28, 1870	31.17	.00180
December 28 and 30, 1870	26.02	.00175
December 30 and 31, 1870	36.00	.00176
December 31, 1870, and January 3, 1871	12.89	.00181
March 27 and 28, 1871	48.94	.00184
March 28 and 29, 1871	39.94	.00187
March 28 and 30, 1871	46.84	.00185
March 30 and 31, 1871	45.53	.00188
April 3 and 4, 1871	49.36	.00181
April 4 and 5, 1871	46.75	.00188
April 5 and 6, 1871	43.91	.00184
April 6 and 7, 1871	27.26	.00181
April 10 and 11, 1871	27.98	.00181
April 11 and 12, 1871	34.78	.00175
April 13 and 13, 1871	29.86	.00181
April 13 and 14, 1871	29.56	.00183
Mean		.001821

In making these experiments, many observations were taken both at high and low temperature. Nearly all those at a low temperature were used, but at high temperatures only those observations which were taken very near a maximum length of bar were used, because when the bar is at its maximum length the thermometer must indicate, very nearly, its true temperature. The temperature and expansion curves were plotted; the observations used were selected after a careful study of these curves. This method has been followed with all the observations made at high temperature. The results given in the preceding table, showing the expansion of the bar and comparator to be .0018211 for 1°. The expansion of the comparators computed from measurement, and determined by experiment, is .00008; subtracting the latter from the former we obtain .00174 United States inches for the expansion of the standard bar for 1° Fahrenheit. These experiments were not considered satisfactory, because each result depends upon two sets of observations made with an average interval of twenty-four hours between them, in which time the piers might have moved, thereby introducing an error. A second series of experiments were therefore made in the following manner. The yards and bar were placed in separate boxes, one above the other. The box holding the yards was filled with pounded ice. This kept the yards at a constant temperature and length, while the temperature of the bar was alternately raised and lowered. Comparator readings were taken on both bar and yards at high and low temperature of the bar, then the difference of the readings of the bar and yards at low temperature, subtracted from the difference of the readings at high temperature, give the expansion of the bar for that change of temperature; then dividing by the difference in temperature gives the expansion for one degree.

The mean results are tabulated below:

Date of observation.	Difference in temperature.	Expansion for one degree.
	Degrees.	
April 10 and 11, 1871	27.98	.00172
April 11 and 12, 1871	34.78	.00175
April 13, 1871	29.86	.00175
April 13 and 14, 1871	29.56	.00173
Mean		.00174

The same result having been obtained in two entirely different ways, .00174 American inches has been adopted as the expansion of the brass standard bar for 1° of temperature, and is probably true to the last place.

The expansion of the tubes was obtained in the following manner: The tube and the standard bar were mounted on the trestles as for ordinary comparison. Comparator readings were taken on both, alternately, at high and low temperature. The difference of the comparator readings at low temperature was subtracted from the difference at high temperature, and the remainder divided by the difference of high and low temperatures; the result was the amount which the bar expands more than the tube for 1°. This quantity was then subtracted from the expansion of the bar, (.00174;) the remainder was the expansion of the tube. The expansion of the yards was determined in the same manner, with a slight difference in the method of reduction, arising from the following cause:

When the expansion of the yards was determined, the yards and the bar were packed in the same box, and covered with cotton, hence their temperatures were practically the same, but when the expansion of the tubes was determined, the bar was placed above the tube, and its temperature was sometimes 8 degrees higher than that of the tube. In this case the comparator readings of the bar were first reduced to that which they would have been if the temperature had been the same as that of the tube. This reduction was made by multiplying the expansion of the bar by the difference in temperature of the bar and tube, and subtracting the result from the comparator reading of the bar.

The mean results are tabulated below:

Tube No. 1.

Date of observation.	Difference of high and low temperature.	Amount which bar expands more than tube.
	Degrees.	
March 27 and 28, 1871	40.11	.00161
March 28 and 29, 1871	31.81	.00161
March 29 and 30, 1871	40.99	.00159
March 30 and 31, 1871	39.43	.00159
Mean		.00160
		.00174
Expansion of tube No. 1 for one degree of temperature		.00014

Tube No. 2.

Date of observation.	Difference of high and low temperature.	Amount which bar expands more than tube No. 2.
	Degrees.	
April 3 and 4, 1871	44.22	.00175
April 4 and 5, 1871	42.33	.00172
April 5 and 6, 1871	45.19	.00170
April 6 and 7, 1871	29.02	.00171
Mean		.00172
		.00174
Expansion of tube No. 2 for one degree of temperature		.00002

Standard yards.

Date of observation.	Difference between high and low temperature.	Amount which yards expand more than bar.
	Degrees.	
November 23 and 25, 1870	23.62	.00002
November 28 and 29, 1870	10.13	.00002
November 29 and 30, 1870	7.42	.00002
Mean		.00002
		.00174
Expansion of yards for one degree of temperature		.00176

The results given in the above table are probably true to the fifth place. The length of the standard bar was determined by comparing it with the standard yard. For this purpose the yards and bar were placed side by side in the same box, and the comparator readings taken on both of them, temperature being taken at the same time. The comparator readings were then reduced to what they would have been if the temperature had been 62°. The difference in the reduced comparator readings was the difference in the length of bar and yards at 62°. The yards were placed in regular order, and their ends kept in contact with spiral springs exerting a pressure of two pounds. Of all the observations taken, 98 were selected which were called good. The mean of these observations showed the yards to be .00107 shorter than the bar. The length of the yards, as previously determined, was 179.99890; hence the length of the bar would be the sum of these two quantities, (179.99997 United States inches.)

The above observations were taken through a range of temperature from 29° to 56°. During the time of the observations, the yards were taken apart and relined eight times. The probable error from observation of final result is .00002. There is, however, an uncertainty of .00100 in the total length of the five yards, when placed end to end, owing to irregularities in their end surfaces. These irregularities were discovered first by a difference in the total lengths of the five yards when placed in different orders; and again by a series of observations made on the central and diagonal lines of each yard. There is no means of obtaining a correction for the irregularities; hence the uncertainty in the length of the yards, and consequently the bar still remains. The lengths given above were adopted for use until better means for comparisons are obtained.

Summary of results obtained.

The thermometers have been found to differ considerably from the standard. Their corrections are tabulated on page 2.

The coefficient, by which the readings of the Baumann comparator No. 1 must be multiplied to reduce them to American inches, is 1.0872.

The same for the Wurdemann comparator No. 1 is 1.0021.

The expansion of the brass standard bar for 1° Fahrenheit is .00174.

The same for five standard yards	.00176
The same for tube No. 1	.00014
The same for tube No. 2	.00002
The same for comparators	.00008

The comparative lengths of the yards differ very much from the lengths marked on them, in one case .00065 inches. Their ends are not planes, but irregular surfaces, making in one case an angle of eight minutes, with the perpendicular to the axis. The sum of the central lines is 179.99890 United States inches, assuming yard No. 5 to be an exact yard.

The length of the standard bar is 179.99997 United States inches, with the uncertainty of .00100 inch. owing to the irregularity of the end surfaces of the yards.

Very respectfully, your obedient servant,

E. S. WHEELER,
Assistant United States Lake Survey.

Major CYRUS B. COMSTOCK,
Corps of Engineers, United States Army.

Appendix E.

OFFICE UNITED STATES LAKE SURVEY,
Detroit, September 30, 1871.

SIR: I have the honor to submit the following report on the meteorology of the lake survey:

In March of the present year, a vacancy having occurred in this department, I was instructed by you to take charge of its computations and to inspect the accuracy with which the observations were being made.

It is but just to state that I found many and perplexing inaccuracies in the records of the observers, and the reductions, especially of the water-gauges, were not in all cases satisfactory.

Having had other duties to perform, being in charge of the computing department of the Lake Survey, and having also an unforeseen amount of astronomical observations to make during the summer, I have had but little time to give to the study of results.

I give herewith, for the years not already published, the results in tables, with as much accuracy as was possible from the data. In accordance with instructions from you bearing date August 7, I visited the stations to the east of Detroit and determined with care the zeros of water-gauges with reference to permanent bench-marks. Where the old bench-marks were to be found the zeros were again referred to these. The amount of error at any one of four stations was not less than half a foot. The heights of the cisterns of the barometers were also determined with reference to the zero of the water-gauges.

* * * * * * *

Very respectfully, your obedient servant,

O. B. WHEELER,
Assistant Lake Survey.

General C. B. COMSTOCK,
Superintendent United States Lake Survey.

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The following table gives the mean monthly water level below the high-water mark of 1838, in feet and decimals of a foot, taken from the bi-five day means, for the months from April to November, inclusive, of the year 1870.

Station.	April.	May.	June.	July.	August.	September.	October.	November.	Mean of 8 months.
Superior	1. 70	1. 50	1. 62	1. 42	1. 43	1. 29	1. 46	1. 91	1. 54
Milwaukee	2. 25	1. 92	2. 62	2. 45	2. 38	2. 24	2. 65	3. 02	2. 57
Detroit	2. 03	1. 62	1. 51	1. 27	1. 38	1. 56	1. 98	1. 24	1. 57
Cleveland	1. 54	1. 36	1. 38	1. 37	1. 41	1. 66	2. 08	2. 36	1. 64
Erie	......	1. 40	1. 38	1. 27	1. 21	1. 58	......	......	......
Charlotte	1. 97	1. 35	1. 57	1. 85	2. 33	......	......	......	......

TABLE I.—*Mean monthly temperatures from eleven years' observations, (from 1860 to 1870, inclusive,) computed by the formula* $A=\frac{7^h+2^h+2(9^h)}{4}$

Stations.	Jan.	Feb.	March.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
	A_0	A_1	A_2	A_3	A_4	A_5	A_6	A_7	A_8	A_9	A_{10}	A_{11}
Superior City, Wis	11.93	13.90	23.02	36.11	*45.85	*55.75	*63.52	62.87	*53.66	*42.13	*29.77	*15.13
Marquette, Mich	†17.32	†17.73	24.31	37.65	48.50	60.02	†65.89	64.15	56.21	44.98	33.60	22.50
Milwaukee, Wis	21.64	24.85	31.36	42.68	52.59	63.46	69.37	67.70	60.73	47.94	37.17	25.56
Detroit, Mich	†24.75	26.86	32.42	45.37	55.95	66.02	†70.80	68.65	61.35	49.01	38.25	28.35
Monroe City, Mich	25.97	28.28	34.01	47.01	58.71	69.60	74.60	72.70	64.63	51.65	40.03	29.66
Cleveland, Ohio	26.89	29.14	34.74	46.92	57.93	68.37	72.90	71.01	64.16	52.32	41.41	30.79
Buffalo, N. Y	24.53	25.22	30,54	42.62	52.98	64.10	69.43	68.06	60.91	*48.49	*38.93	*28.58
Fort Niagara, N. Y	24.55	25.15	30.22	40.85	51.52	63.92	70.51	68.76	61.35	49.70	39.11	28.41
Charlotte, N. Y	25.91	27.05	32.46	44.13	54.66	66.02	71.46	69.95	62.79	50.43	39.98	29.72
Sackett's Harbor, N. Y	21.55	22.77	29.56	43.15	54.50	65.07	70.83	69.87	62.22	50.13	41.90	26.17

* These values are obtained from but ten years' observations.

† These values are bi-five days' means of January 15, February 15, and July 15, respectively.

Formula for the temperature curve, placing the origin at January 15.

$$A = a_0 + a_1 \cos \theta + a_2 \cos 2\theta + a_3 \cos 3\theta;$$

$$\text{for the N}^{\text{th}}\text{ day, } \theta = \frac{N}{365.25} \times 360^\circ + b_1 \sin \theta + b_2 \sin 2\theta + b_3 \sin 3\theta$$

TABLE 2 *of the constants in this formula and the mean errors computed from Table* 1.

Stations.	a_0	a_1	a_2	a_3	b_1	b_2	b_3	e_0
Superior City, Wis	37.803	—25.423	—0.853	—0.812	—3.801	+1.003	—0.388	±0.92
Marquette, Mich	41.013	—24.111	+0.362	—0.295	—4.300	—0.320	—0.378	±0.49
Milwaukee, Wis	45.388	—23.285	+0.008	—0.490	—3.269	+0.788	+0.118	±0.55
Detroit, Mich	47.315	—23.030	+0.354	+0.097	—2.571	+0.102	—0.080	±0.52
Monroe City, Mich	49.738	—24.390	+0.557	+0.112	—2.750	+0.232	+0.027	±0.53
Cleveland, Ohio	49.715	—22.964	+0.181	—0.012	—3.119	+0.079	+0.185	±0.46
Buffalo, N. Y	46.199	—22.495	+0.743	—0.080	—3.944	+0.020	—0.242	±0.57
Fort Niagara, N. Y	46.171	—23.112	+1.088	—0.403	—4.852	+0.364	+0.125	±0.48
Charlotte, N. Y	47.880	—22.774	+0.706	—0.090	—3.859	+0.270	—0.050	±0.48
Sackett's Harbor, N. Y	46.477	—24.398	—0.508	—0.670	—1.739	—0.465	—0.203	±1.04

The same formula under the following form, placing the origin at the beginning of the year:

$$A = A + B_1 \sin(\Theta + C_1) + B_2 \sin(2\Theta + C_2) + B_3 \sin(3\Theta + C_3)$$

where

$$A = a_0;\quad C_r + 15r = \tan^{-1}\left(=\frac{a_r}{b_r}\right);$$

$$B_r = \frac{a_r}{\sin(C_r + 15r)} = \sqrt{a_r^2 + b_r^2};\quad \Theta = \frac{N}{365.25} \times 360^\circ$$

for the Nth day from January 1st.

TABLE 3 *of the constant in this formula.*

Stations.	A	B	B_2	B_3	C	C_2	C_3
					° ′ ″	° ′ ″	° ′ ″
Superior City, Wis	37.803	25.71	1.32	0.90	246 30 00	289 38 30	199 26 00
Marquette, Mich	41.013	24.49	0.48	0.42	244 53 10	101 32 20	161 21 40
Milwaukee, Wis	45.388	23.51	0.79	0.59	247 00 30	330 36 10	238 32 50
Detroit, Mich	47.315	23.17	0.37	0.125	248 37 50	43 52 30	84 36 40
Monroe City, Mich	49.738	24.54	0.60	0.115	248 34 00	37 23 00	31 34 00
Cleveland, Ohio	49.715	23.175	0.20	0.185	247 15 50	36 15 10	311 23 30
Buffalo, N. Y	46.199	22.78	0.73	0.25	245 02 00	58 25 20	153 19 20
Fort Niagara, N. Y	46.171	23.62	1.14	0.42	243 08 40	41 26 40	242 13 00
Charlotte, N. Y	47.880	23.10	0.76	0.10	245 23 00	39 04 30	195 56 30
Sackett's Harbor, N. Y	46.477	24.85	0.69	0.70	244 00 30	197 30 50	208 07 00

TABLE 4.—*Minima, maxima, and vernal and autumnal mean.*

Stations.	Minima.		Maxima.		Vernal mean.	Autumnal mean.
	Fahrenheit.	Date.	Farhenheit.	Date.	Date.	Date.
	°		°			
Superior City, Wis	10.59	January 20	63.98	July 28	April 23	October 25
Marquette, Mich	16.27	January 28	66.18	July 25	April 26	October 25
Milwaukee, Wis	21.59	January 18	69.52	July 25	April 25	October 24
Detroit, Mich	24.60	January 23	70.77	July 23	April 23	October 21
Monroe City, Mich	25.90	January 21	74.76	July 22	April 23	October 21
Cleveland, Ohio	26.78	January 22	73.02	July 22	April 24	October 23
Buffalo, N. Y	23.86	January 28	69.93	July 26	April 27	October 23
Fort Niagara, N. Y	23.41	January 25	71.20	July 25	May 1	October 25
Charlotte, N. Y	25.41	January 26	71.78	July 26	April 28	October 23
Sackett's Harbor, N. Y	20.31	January 26	71.38	July 24	April 25	October 29

* * * * * * *

Very respectfully, your obedient servant,

O. B. WHEELER *Assistant Lake Survey.*

General C. B. COMSTOCK,
Superintendent United States Lake Survey.

SUPERIOR CITY, WISCONSIN.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	2.2	12.3	0.0	0.0	0.0	31.5	5.6	11.2	37.1
February	1.3	28.7	0.0	0.0	1.3	28.7	2.5	1.3	36.2
March	3.3	31.1	0.0	0.0	0.0	7.8	1.1	3.3	53.3
April	4.5	40.9	0.0	0.0	0.0	25.0	2.3	0.0	27.3
May	5.3	66.7	2.7	0.0	0.0	14.7	2.7	8.0	0.0
June	1.1	62.2	2.2	3.3	0.0	26.7	3.3	1.1	0.0
July	0.0	34.4	1.1	1.1	0.0	54.8	5.4	3.2	0.0
August	1.1	17.0	1.1	13.6	12.5	21.6	1.1	19.3	12.5
September	5.6	42.2	15.6	4.4	11.1	7.8	0.0	5.6	7.8
October	2.2	16.3	8.7	2.2	7.6	22.8	12.0	21.7	6.5
November	3.3	8.9	1.1	1.1	10.0	30.0	15.6	20.0	10.0
December	4.3	15.1	3.2	0.0	2.2	34.4	18.3	15.1	7.5

MARQUETTE, MICHIGAN.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	14.0	9.7	4.3	4.3	8.6	15.1	20.4	15.1	8.6
February	6.0	2.4	11.9	8.3	6.0	13.1	15.5	25.0	11.9
March	27.2	8.7	10.9	3.3	2.2	5.4	16.3	4.3	21.7
April	24.4	2.2	6.7	1.1	12.2	8.9	13.3	7.8	23.3
May	18.3	2.2	8.6	18.3	11.8	8.6	5.4	7.5	19.4
June	25.6	3.3	7.8	4.4	17.8	1.1	4.4	15.6	20.0
July	20.4	2.2	8.6	3.2	20.4	9.7	12.9	12.9	9.7
August	15.0	1.1	3.2	10.8	18.3	12.9	22.6	11.8	4.3
September	23.3	5.6	2.2	3.3	7.8	6.7	12.2	11.1	27.8
October	11.8	6.5	3.2	10.8	17.2	7.5	20.4	15.1	6.5
November	4.4	2.2	3.3	6.7	11.1	14.4	22.2	25.6	10.0
December	5.4	9.7	2.2	6.5	9.7	5.4	37.6	16.1	7.5

MILWAUKEE, WISCONSIN.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	0.0	10.1	5.6	14.6	12.4	23.6	5.6	4.5	23.6
February	0.0	12.3	2.5	7.5	0.0	28.7	3.8	5.0	40.0
March	1.1	16.1	2.2	3.2	1.1	17.2	4.3	25.8	29.0
April	0.0	6.7	2.2	10.1	0.0	7.9	1.1	33.7	38.2
May	2.4	9.6	3.6	1.2	2.4	3.6	3.6	18.1	55.4
June	1.2	9.4	0.0	4.7	0.0	8.2	0.0	9.4	67.0
July	0.0	12.4	2.2	23.6	0.0	7.9	3.4	14.6	35.9
August	2.2	15.7	4.5	15.7	5.6	7.9	0.0	2.2	46.1
September	6.7	11.1	0.0	2.2	0.0	1.1	2.2	24.4	52.2
October	3.6	13.1	0.0	13.1	10.7	17.9	6.0	20.2	15.5
November	2.3	8.1	0.0	7.0	1.2	23.3	2.3	23.3	32.6
December	4.7	5.8	0.0	3.5	2.3	17.4	8.1	27.9	30.2

DETROIT, MICHIGAN.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	5.4	12.9	6.5	9.7	18.3	25.8	15.0	6.5	0.0
February	7.1	7.1	10.7	7.1	10.7	15.5	21.4	20.2	0.0
March	6.5	21.5	19.3	1.1	6.5	11.8	14.0	19.3	0.0
April	15.6	35.6	5.6	6.7	17.8	10.0	3.3	5.6	0.0
May	5.4	28.0	15.1	11.8	8.6	21.5	5.4	4.3	0.0
June	8.9	18.9	12.2	4.4	24.4	16.7	8.9	5.6	0.0
July	5.4	15.1	6.5	9.7	26.9	22.6	3.2	10.8	0.0
August	9.7	9.7	11.8	5.4	19.4	30.1	6.5	7.5	0.0
September	20.0	23.3	21.1	5.6	11.1	8.9	1.1	8.9	0.0
October	9.7	12.9	9.7	3.2	12.9	23.7	18.3	9.7	0.0
November	7.8	4.4	3.3	1.1	20.0	32.2	17.8	13.3	0.0
December	4.3	3.2	5.4	3.2	17.2	30.8	24.7	2.2	0.0

MONROE CITY, MICHIGAN.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	12.0	7.2	4.8	9.6	6.0	32.5	14.5	13.4	0.0
February	6.0	26.2	4.8	9.5	3.6	10.7	16.7	22.6	0.0
March	11.8	34.4	7.5	4.3	2.2	7.5	9.7	22.6	0.0
April	16.7	28.9	10.0	14.4	4.4	8.9	0.0	16.7	0.0
May	10.8	29.0	10.8	6.5	7.5	20.4	10.8	4.3	0.0
June	6.7	22.2	8.9	6.7	14.4	22.2	2.2	16.7	0.0
July	5.4	8.6	6.5	7.5	15.0	18.3	21.5	17.2	0.0
August	9.7	17.2	1.1	5.4	17.2	20.4	11.8	17.2	0.0
September	20.0	31.1	7.8	7.8	7.8	5.6	2.2	16.7	0.0
October	9.7	19.4	1.1	6.5	4.3	33.3	7.5	18.3	0.0
November	14.0	7.0	1.2	7.0	16.3	25.6	5.8	23.3	0.0
December	8.6	10.8	0.0	3.2	15.1	37.6	8.6	16.1	0.0

CLEVELAND, OHIO.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	2.2	16.1	1.1	7.5	32.3	17.2	14.0	7.5	2.2
February	13.1	7.1	0.0	11.9	16.7	15.5	10.7	22.6	2.4
March	4.3	20.4	2.2	12.9	5.4	8.6	17.2	27.9	1.1
April	13.3	28.9	0.0	12.2	18.9	3.3	4.4	15.6	3.3
May	11.3	26.9	2.2	3.2	18.3	10.8	9.7	12.9	4.3
June	13.3	12.2	1.1	6.7	27.8	13.3	3.3	21.1	1.1
July	7.5	18.3	0.0	6.5	20.4	19.4	9.7	16.1	2.1
August	17.2	16.1	0.0	14.0	20.4	15.1	8.6	6.5	2.1
September	12.2	28.9	0.0	23.3	16.7	7.8	3.3	5.6	2.2
October	2.2	14.0	2.1	17.2	12.9	31.2	9.7	8.6	2.1
November	1.1	15.6	0.0	6.7	27.8	24.4	8.9	15.6	0.0
December	1.1	6.5	0.0	11.8	21.5	32.3	11.8	15.0	0.0

BUFFALO, NEW YORK.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	3.2	11.8	5.4	5.4	25.4	28.0	14.0	26.9	0.0
February	2.4	20.2	6.0	4.8	8.3	16.7	8.3	33.3	0.0
March	1.1	34.4	4.3	2.2	4.3	12.9	15.1	25.8	0.0
April	3.3	35.6	4.4	3.3	2.2	36.7	2.2	12.2	0.0
May	0.0	24.7	4.3	5.4	5.4	47.3	6.5	6.5	0.0
June	3.3	10.0	3.3	3.3	1.1	63.3	5.6	10.0	0.0
July	0.0	12.0	4.3	2.2	6.5	66.3	6.5	2.2	0.0
August	0.0	8.6	4.3	5.4	4.3	48.4	9.7	19.3	0.0
September	3.4	28.4	13.6	5.7	4.5	18.2	9.1	17.0	0.0
October	0.0	28.0	5.4	2.2	6.5	40.9	6.5	10.8	0.0
November	1.1	14.4	2.2	4.4	0.0	32.2	6.7	38.9	0.0
December	5.4	5.4	4.3	5.4	0.0	21.5	23.7	34.4	0.0

FORT NIAGARA, NEW YORK.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	4.3	9.7	7.5	2.2	9.7	8.6	49.4	8.6	0.0
February	13.1	14.3	6.0	2.4	14.3	3.6	36.9	9.0	0.0
March	20.4	17.2	18.3	4.3	4.3	6.5	19.4	9.7	0.0
April	17.8	24.4	5.6	1.1	15.6	6.7	24.4	4.4	0.0
May	8.6	34.4	4.3	1.1	4.3	11.8	30.1	5.4	0.0
June	14.4	13.3	3.3	1.1	6.7	14.4	41.1	5.6	0.0
July	7.5	6.5	1.1	0.0	11.8	25.8	34.4	12.9	0.0
August	15.1	23.7	3.2	0.0	15.1	20.4	17.2	5.4	0.0
September	10.0	31.1	4.4	4.4	12.2	27.8	4.4	5.6	0.0
October	2.2	19.4	9.7	0.0	15.1	26.9	20.4	5.4	0.0
November	16.7	12.2	1.1	0.0	7.8	31.1	16.7	14.4	0.0
December	26.9	10.8	0.0	0.0	8.6	26.9	22.6	4.3	0.0

CHARLOTTE, NEW YORK.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	4.4	5.5	14.3	11.0	16.5	26.4	15.4	6.6	0.0
February	10.7	7.1	9.5	5.9	9.5	15.5	20.3	21.5	0.0
March	13.0	13.0	15.2	6.5	2.2	5.4	27.2	17.4	0.0
April	19.3	10.2	18.2	9.1	13.6	3.4	12.5	12.5	0.0
May	17.6	8.8	22.0	2.2	12.1	9.9	7.7	19.8	0.0
June	14.1	8.2	12.9	4.7	18.8	9.4	20.0	11.8	0.0
July	10.8	3.2	8.6	1.1	29.0	10.8	13.9	23.7	0.0
August	19.6	6.5	3.3	0.0	23.9	14.1	28.3	4.3	0.0
September	15.9	10.2	17.0	1.1	22.7	5.7	13.6	13.6	0.0
October	8.0	9.2	9.2	8.0	38.3	10.3	11.5	10.3	0.0
November	20.7	4.6	3.4	2.3	19.5	21.8	20.7	6.9	0.0
December	11.2	2.2	5.6	4.5	16.9	13.5	30.3	15.7	0.0

SACKET'S HARBOR, NEW YORK.

Percentage of winds from the different points of compass for the year 1870.

Months.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
January	4.3	22.6	2.2	2.1	29.1	14.0	12.9	6.5	6.4
February	10.7	25.0	2.4	2.4	14.3	6.0	3.6	11.9	23.8
March	15.2	26.1	4.3	2.2	7.6	5.4	3.3	6.5	29.4
April	2.2	33.3	5.6	0.0	13.3	13.3	8.9	1.1	22.2
May	5.4	24.7	5.4	1.1	19.4	19.3	8.6	2.1	14.0
June	1.1	9.0	5.6	4.5	34.8	23.6	10.1	1.1	10.1
July	0.0	4.1	1.3	4.1	32.4	23.0	27.0	1.3	6.8
August	2.2	4.3	6.5	2.2	20.6	21.7	17.4	2.2	13.0
September	6.8	25.0	6.8	1.1	25.0	6.8	9.1	3.4	15.9
October	6.5	19.3	6.5	1.1	25.8	16.1	16.1	5.4	3.2
November	10.1	14.6	4.5	0.0	20.2	14.6	18.0	9.0	9.0
December	5.4	21.5	3.2	0.0	16.1	15.1	17.2	12.9	8.6

Annual percentage of winds from the different points of compass for the year 1870.

Stations.	N.	N. E.	E.	S. E.	S.	S. W.	W.	N. W.	Calms.
Superior City	2.8	30.8	3.0	2.2	3.8	25.7	6.0	9.3	16.4
Marquette	16.4	4.7	6.0	6.8	12.0	9.0	17.0	14.0	14.2
Milwaukee	2.0	10.9	1.9	8.9	3.0	13.6	3.4	17.6	38.7
Detroit	8.8	16.1	10.6	5.7	16.2	21.6	11.6	9.4	0.0
Monroe City	10.9	20.3	5.4	7.3	9.5	20.3	9.2	17.1	0.0
Cleveland	81.2	17.6	7.3	11.1	19.9	16.6	9.3	13.9	1.9
Buffalo	1.9	19.4	5.1	4.1	4.0	36.2	9.5	19.7	0.0
Fort Niagara	13.1	18.1	5.4	1.4	10.5	17.6	26.6	7.6	0.0
Charlotte	13.8	7.4	11.6	4.7	18.2	12.2	18.4	13.7	0.0
Sacket's Harbor	5.9	19.6	4.6	1.7	21.6	15.0	12.6	5.4	13.7

Appendix F.

OFFICE UNITED STATES LAKE SURVEY,
Detroit, Michigan, October 24, 1871.

SIR: I have the honor to submit the following report, in relation to the late observations and reductions, for the determination of the difference of longitude between Washington, D. C., and Detroit, Michigan.

The observations were made on the nights of May 19, 23, and 24. The method employed was that by transmission of clock-signals. By this method the two clocks are compared by connecting first one and then the other with the telegraph wire, and thus causing them both to record their beats simultaneously, first upon the chronograph at one station, and then upon that at the other. By the use of signals, transmitted in both directions, the wave-time, and the loss of time in the use of repeaters, becomes practically eliminated. The errors and rates of the clocks and the relative personal equation of the observers being determined, the difference of time between the two stations thus becomes known.

The observer at Washington was Professor John R. Eastman, of the United States Naval Observatory, and the instruments used there were the old transit instrument and the Mural clock, together with a chronograph and the necessary telegraphic apparatus. This transit instrument is mounted on the east wing, at a distance of 42.9 feet, or 0^{s}.036 east of the center of the dome of the Naval Observatory. The transit used by myself at Detroit was the one known as the old Troughton & Simms, the focal length of its object-glass being 42 inches. The clock and chronograph used here were respectively Nos. 184 and 216, Bond & Son. The former Lake Survey Observatory, on Washington avenue, was taken down in March, 1870. The present one, on Grand River avenue, in rear of the Lake Survey office, was built in March of the present year; and the east transit stone pier, used in this connection, is 143.7 feet (equal to 0^{s}.127) west, and 146.6 feet (equal to 1^{s}.45) north of the west transit pier of the old observatory. The east pier, above mentioned, is also 321.0 feet west, and 294.0 feet north from the southwest corner of the stone foundation of the Westminster church, on Washington avenue.

The Lake Survey Observatory is situated near a paved street, on which loaded wagons and street-cars are passing until a late hour. On this account, all stars observed before Polaris were rejected, and the others retained are probably more discordant than otherwise would have been.

A preliminary reduction, by high and low stars, was made by Sub-Assistant C. F. Burton. Two reductions, by the method of least squares, have been made by Sub-Assistant Thomas Russell. In the first reduction, by Mr. Russell, the observations were grouped in two sets for each night. The error of clock was determined from each, and the rate of clock for the interval, during which interval the clocks were compared, was found from these errors. In the second reduction, by Mr. Russell, the results of which are here given, the rate enters into the equations of condition as an unknown quantity, and all the stars are combined in one set of equations. In the preliminary reduction and the first reduction, by least squares, all the stars observed were used with the above exceptions. There was, however, in this final reduction, one star rejected on the 23d and six on the 24th; five of these were zenith stars; and the tortuous position in observing these stars gives a sufficient excuse for rejecting them. Allow me here to state that the two reductions by least squares would effect a difference in the longitude of only 0^{s}.02, and would cause an extreme difference of only 0^{s}.05 from the preliminary reduction.

The wire intervals were re-determined from observations on circumpolar stars, made on nights when we failed to work with other stations. They were found to be essentially the same as when put in seven years ago.

The inequality of pivots was also re-determined.

The results for error of clock No. 184 and rate for the three nights are as follows, taken from the tables appended to this report:

Date.	By clock 184.		Clock correction.	Rate per hour.
	hrs.	min.	sec. sec.	sec.
May 19	15	57	—31.54±0.023	+0.1493
May 23	16	04	—42.08±0.019	+0.1471
May 24	15	54	—45.28±0.020	+0.0983

Owing to the disturbances incident to the situation of the Observatory, the rate from day to day has been considered of no value from the beginning. The rate, however, during the time of observation on any night, when the disturbances had nearly ceased, may be considered nearly uniform.

The results for the error of the Mural clock, at Washington, as furnished by an early letter, are herewith given. These were not considered as the final results, and the probable errors were not given. The resulting difference of longitude may, therefore, be subject to some small change.

Date.	By mural clock.		Clock correction.	Rate per hour.
	hrs.	min.	sec.	sec.
May 19	18	36	—0.78	+0.0444
May 23	18	54	+2.68	+0.0432
May 24	18	00	+2.15	—0.0078

The following explanation in regard to the clock corrections is copied from Admiral Sands's letter:

"On account of a lack of maintaining power, the clock generally loses two or three seconds when it is wound, and as it was wound on the 22d, this fact will account for the large difference of error between the 19th and 23d."

Observations for relative personal equation were made by Professor Eastman and myself, at Washington, on the nights of August 9, 10, and 11. The same instruments were used as were used by Professor Eastman on May 19, 23, and 24. The stars selected were within the limits of +40° and +30° declination. The first observer on any star observed over the first and last tallies of five wires each; the second observer observed on the second, third, and fourth tallies, the second and fourth having three wires each, the third having five wires. The observers became alternately first and second on alternate stars. Any error in determination of wire intervals was thus eliminated. The reduction has been made here by Mr. Burton with the following results, where E stands for Professor Eastman and W for myself:

August 9, number of stars observed 11. E—W=+0.036±0.016.
August 10, number of stars observed 22. E—W=+0.002±0.006.
August 11, number of stars observed 13. E—W=+0.057±0.008.

Which combined, with due regard to the probable errors, gives

$$E-W=+0.017\pm0.0046.$$

It is proper here to state that on the 9th I had not become accustomed to the use of a make-circuit key, having formerly used a break-circuit; and also that on the 11th the sky was hazy and the stars unsteady.

The comparison of clocks is from the mean of 121 consecutive second breaks from both chronograph sheets on each night, with this exception, that on the night of the 23d, on the Detroit chronograph, the two clock-breaks so nearly coincided that there was an uncertainty in reading. On this account only 18 consecutive second-breaks were used, where the Detroit clock was cut out, in determining the fractional part of a second. This result, however, would differ but little from the mean of 121, as estimated. The following table gives a direct comparison of clocks:

Date.	DETROIT CHRONOGRAPH.		WASHINGTON CHRONOGRAPH.	
	Mural clock.	Clock No. 184.	Mural clock.	Clock No. 184.
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*
May 19, 1871	18 39 00.00=	18 15 30.93	19 06 15.32=	18 42 46.00
May 23, 1871	19 04 00.00=	18 40 45.18	19 07 30.08=	18 44 15.00
May 24, 1871	18 01 10.00=	17 37 57.70	18 14 13.60=	17 51 01.00

Which, with the clock connection applied, (omitting the probable errors,) becomes as follows:

Date.	DETROIT CHRONOGRAPH.		WASHINGTON CHRONOGRAPH.	
	Mural clock.	Clock No. 184.	Mural clock.	Clock No. 184.
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*
May 19, 1871	18 38 59.22=	18 14 59.05	19 06 14.52=	18 42 14.05
May 23, 1871	19 04 02.67=	18 40 02.72	19 07 32.75=	18 43 32.53
May 24, 1871	18 01 12.15=	17 37 12.25	18 14 14.75=	17 50 14.53

If then we assume a probable error of ±0.01 for that of the Washington clock correction, which is about that given in published reports, we have for the difference of longitude, and wave and armature time, the following: (The probable error in the transmission of signals, and in the reading of the chronographic record, being neglected.)

Date.	DIFFERENCE OF LONGITUDE.			Wave and armature time.
	From Detroit record.	From Washington record.	Mean.	
	m. s. s.	*m. s. s.*	*m. s. s.*	*s.*
May 19, 1871	24 00.17±0.025	24 00.47±0.025	24 00.32±0.025	0.150
May 23, 1871	23 59.95±0.021	24 00.22±0.021	24 00.09±0.021	0.135
May 24, 1871	23 59.90±0.022	24 00.22±0.022	24 00.06±0.022	0.160

Hence we have for the final result:

$$24^{m}\ 00^{s}.14 \pm 0^{s}.0.13$$

Applying the value of personal equation $= +0^{s}.02 \pm 0^{s}.005$ and the correction for reduction to the dome of the Naval Observatory $= +0^{s}.04$, we have longitude of present Lake Survey Observatory west of Washington,

$$24^{m}\ 00^{s}.12 \pm 0^{s}.02\,;$$

and applying correction $= -0^{s}.13$, to reduce to former Lake Survey Observatory, we have longitude of former Lake Survey Observatory, west of Washington,

$$23^{m}\ 59^{s}.99 \pm 0^{s}.02.$$

* * * * * * * *

Very respectfully submitted.

O. B. WHEELER,
Assistant Lake Survey.

General C. B. COMSTOCK,
Superintendent of U. S. Lake Survey.

NOTE.—On the 19th and 24th there were repeaters in the circuit at Detroit, Cleveland, Pittsburgh, and Philadelphia. On the 23d there were repeaters at Detroit, Cleveland, Cincinnati, Pittsburgh, and Philadelphia.

Appendix G.

OFFICE UNITED STATES LAKE SURVEY,
Detroit, Michigan, September 12, 1871.

SIR: The general results from the astronomical observations of last season I have the honor to report as follows:

Tables Nos. 1, 2, and 3 contain the results for the latitudes of the astronomical stations, Porcupine Mountains, Outer Island, and East Sawteeth Mountains, Lake Superior.

Table No. 4 gives the differences in longitude between the primary triangulation stations of the same names, with that of Farquhar's Knob included.

There is added also the differences in latitude and longitude between the astronomical and primary triangulation stations.

The observations for Tables Nos. 1 and 3 were made by Assistant G. Y. Wisner, assisted by Mr. E. M. Cooley, with the Würdemann zenith telescope No. 12, of 32 inches focal length. Those for Table No. 2 were made by Assistant A. R. Flint, assisted by Mr. Clark Olds, with No. 18 Würdemann zenith telescope, same size as the above.

The stars were selected, so far as it was possible, from the corrected catalogues prepared by Professor T. H. Safford; a few have the authority of the B. A. C. catalogue only, but those stars from this catalogue in which large errors have been detected are those corrected by Professor Safford. So that it is probable that only the most reliable stars of the B. A. C. catalogue are used on its authority alone. Equal weights have been given to all the declinations. The first computations were made by Assistants Flint and Wisner. A second reduction was made by Assistant Foote and Sub-Assistant G. W. Mickle. The two reductions were compared and checked. No results have been rejected unless it is found that the wrong star was observed. The night results are combined with due regard to the probable error of the mean result for each night.

The observations for Table No. 4 were made by Assistant Flint, and Mr. Olds as recorder, at stations Wheal Kate and East Sawteeth Mountains, with No. 13 Würdemann transit of 26 inches focal length; by Assistant Wisner, with Mr. Cooley as recorder, at stations Porcupine Mountains, with No. 1 Würdermann transit of 32 inches focal length; by myself, with Mr. J. C. Jones as recorder, at Farquhar's Knob, with the Berlin instrument of 26 inches focal length.

For these differences in longitude, the usual Lake Survey methods, where there are no telegraph lines, were used.

Twenty to thirty stars are observed at each station on each night, and a comparison of chronometers made by means of about twenty powder flashes made at about the mean time of observation. The first reduction was made by Assistants Flint and Wisner; a second was made by Sub-Assistant Thos. Russell, and a comparison of the two made by Mr. Russell. Since there are no determinations for personal equation between the observers or between each observer and his recorder, a discussion of the probable errors has been omitted.

The differences between the extreme stations, Wheal Kate and East Sawteeth, determined through the intermediate station Porcupine Mountains, may be considered a correct result since the personal equations are eliminated. In comparing to-day, for the first time, the differences in longitude, as determined from astronomical observation with those determined by triangulation, I find for the above case a discrepancy of only

0s.15. This does not indicate a very great error in longitude arising from local attraction, while the discrepancy in latitude existing between the same stations has been found to be about 1,000 feet. The discrepancy, however, between Wheal Kate and Porcupine Mountains obtained in the same manner is in longitude 1s. 78, or nearly 2,000 feet.

This indicates a very large error in longitude arising from local attraction, since but a small portion of this can well be attributed to the uneliminated personal equations. The discrepancy in latitude is nearly 400 feet. Farquhar's Knob, in connection with Wheal Kate, does not give any greater discrepancy in longitude than might be attributed to personal equations. It is 0s. 28. The discrepancy in latitude is about 300 feet.

I am, very respectfully, your obedient servant,

O. B. WHEELER,
Assistant Lake Survey.

Brevet Brigadier General C. B. COMSTOCK,
Major Corps of Engineers, Superintendent Lake Survey.

Latitude of United States Lake Survey astronomical station, Porcupine Mountains, Lake Superior.

TABLE NO. 1.—GENERAL RESULTS.

Date.	No. of pairs of stars observed.	Mean result of each night.	Probable error of—	
			A single result.	Mean result.
		° ′ ″	″	″
October 19, 1869	10	46 47 04. 2	± 1. 04	± 0. 331
June 20, 1870	24	46 47 03. 6	± 0. 91	± 0. 187
June 22, 1870	29	46 47 03. 1	± 1. 14	± 0. 211
July 1, 1870	17	46 47 03. 9	± 0. 89	± 0. 216
Sum	80	Final result = 46° 47′ 03″.61.		

Latitude of United States Lake Survey astronomical station, East Sawteeth Mountains, Lake Superior.

TABLE NO. 2.—GENERAL RESULTS.

Date.	No. of pairs of stars observed.	Mean result of each night.	Probable error of—	
			A single result.	Mean result.
		° ′ ″	″	″
July 18, 1870	13	47 23 08. 42	± 0. 99	± 0. 274
July 20, 1870	48	47 23 07. 90	± 1. 33	± 0. 192
July 24, 1870	39	47 23 07. 46	± 1. 16	± 0. 185
Sum	100	Final result = 47° 23′ 07″.81.		

Latitude of United States Lake Survey astronomical station, Outer Island, Lake Superior.

TABLE NO. 3.—GENERAL RESULTS.

Date.	No. of pairs of stars observed.	Mean result of each night.	Probable error of—	
			A single result.	Mean result.
		° ′ ″	″	″
August 13, 1870	39	47 04 14. 04	± 1. 314	± 0. 210
August 26, 1870	52	47 04 14. 65	± 0. 839	± 0. 116
Sum	91	Final result = 47° 04′ 14″. 51		

Results for difference in longitude reduced to primary triangulation stations, Lake Superior.

TABLE NO. 4.—GENERAL RESULTS.

Date.	DIFFERENCE OF LONGITUDE.			
	Porcupine Mountains, west of Wheal Kate.	Farquhar's Knob, west of Porcupine Mountains.	East Sawteeth, west of Porcupine Mountains.	East Sawteeth, west of Farquhar's Knob.
	h. m. s.	*h. m. s.*	*h. m. s.*	*h. m. s.*
June 16, 1870	0 04 18.33	0 01 00.61		
June 17, 1870	0 04 18.07	0 01 00.81		
July 2, 1870			0 05 44.31	
July 7, 1870			0 05 44.07	
July 27, 1870			0 05 43.93	
August 3, 1870				0 04 43.32
Mean	0 04 18.20	0 01 00.71	0 05 44.10	0 04 43.32

Porcupine Mountains primary triangulation station is ..... $S = 0''.444$. $W = 0^{s}.014$
Farquhar's Knob primary triangulation station is .... $N = 0''.059$. $W = 0^{s}.024$
Outer Island primary triangulation station is .... $N = 0''.349$. $E = 0^{s}.011$
East Sawteeth primary triangulation station is .... $S = 0''.454$. $E = 0^{s}.019$
from observatory post.

Appendix H.

SEPTEMBER 26, 1871.

MAJOR: I have the honor to submit the following report of the work accomplished by the surveying party under my orders during the past season.

I arrived at Whitehall, New York, on the 26th of May, 1871, and remained until the 25th instant, engaged upon a survey of the portion of Lake Champlain extending from its head to a distance of thirteen and one-half miles.

Both shore-lines were surveyed, together with the interior edges of the marshes. Also the main-land back from the marshes to such a distance as the nature of the topography required.

The lake was sounded in lines, running between flags established along the shores, at equal distances from each other. In the harbor of Whitehall, the flags were placed twenty meters apart, and the diagonals were sounded as well as the sides of the rectangles thus formed. For a distance of half a mile beyond the harbor the flags were placed forty meters apart, and after that eighty meters apart. This gives a sufficiently correct idea of the depth and of the nature of the bottom. Between the points established by triangulation, the shore-lines were run by azimuths and stadia-readings mostly. The chain could not be used very well, as the marshes were very soft.

* * * * * * *

The portion of Lake Champlain surveyed is very narrow, and is lined with marshes of considerable extent. These marshes render the course of the lake extremely tortuous, and this, together with the shallowness of the water, makes navigation difficult. From inquiries made of residents of Whitehall, and pilots, I learn that the lake is filling up from deposition of the sediment caused by the washing of the shores, and that brought in by the freshets. No one could inform me as to the rate of deposition.

The height of the water varies very much some years. In the year 1841 I am told that the difference of line between high-water mark and low water was within a few tenths of being ten feet. A strong north wind will "pile up" the water in Whitehall Harbor to a height of fourteen to eighteen inches above the water-mark of calm weather. A south wind will depress the water-line from 8 to 10 inches. The water partially returning to its original height will cause a current, which is the only one ever perceptible in this portion of the lake.

Whitehall is situated at the head of the lake, and also at the head of the Champlain Canal; consequently a great quantity of material passes through Whitehall, both north and south. I submit the following as giving some idea of the quantity of material transported on the lake. The books at the custom-office show that 43,200,000 feet of lumber during the past season has been deposited at Whitehall. This is the amount of which the officer at Whitehall alone takes notice. Besides this amount, there are about 30,000 000 feet which come to Whitehall, but the revenue from which is collected at Burlington and Plattsburgh. The average value of this lumber is $10 50 per thousand feet. As the tax on lumber is 20 per cent. of the cost, the Government derives a revenue of at least $153,720 in one season of four months. * * *

I am, major, very respectfully, your obedient servant,

EDWARD MAGUIRE,
Second Lieutenant of Engineers.

Major C. B. COMSTOCK,
Corps of Engineers, U. S. A.,
Supt. U. S. Lake Survey, Detroit, Michigan.

Appendix I.

TABLE SHOWING THE ANNUAL ISSUE OF CHARTS.

Prior to October 1, 1857	2,500
October 1, 1857, to October 1, 1858	1,675
October 1, 1858, to October 1, 1859	2,600
October 1, 1859, to October 1, 1860	4,890
October 1, 1860, to October 1, 1861	3,254
October 1, 1861, to October 1, 1862	5,245
October 1, 1862, to October 1, 1863	4,084
October 1, 1863, to October 1, 1864	3,283
October 1, 1864, to October 1, 1865	2,589
October 1, 1865, to October 1, 1866	2,082
July 1, 1866, to July 1, 1867	5,464
July 1, 1867, to July 1, 1868	6,354
July 1, 1868, to July 1, 1869	5,634
July 1, 1869, to July 1, 1870	4,597
July 1, 1870, to July 1, 1871	5,328

Appendix K.

NEW HAVEN, CONNECTICUT, *October* 9, 1871.

GENERAL: I have the honor to submit herewith a preliminary report on the dredging carried on, under your instructions, in Lake Superior, during August and the early part of September. I regret that the short time since the dredging was completed has been insufficient for more than a hasty examination and review of the materials collected, and that consequently the following report is quite imperfect as regards the microscopic species.

I wish here to acknowledge the generous assistance of Professor Verrill, who very kindly procured dredges and other apparatus for me, and who has since determined the worms and aided me by advice in many ways.

Very respectfully, your obedient servant,

SIDNEY I. SMITH.

Brevet Brigadier General C. B. COMSTOCK,
Major of Engineers, in charge U. S. Lake Survey.

REPORT.

The dredgings were all made from the steamer Search, and were carried on wholly by hand. The dredges used were like those commonly employed in marine dredging, with the addition of an inner bag of embroidery canvas, which was found necessary to retain the exceedingly fine clayey mud encountered at nearly every haul. Owing to rough weather and the employment of the steamer for other purposes, the dredgings were not so numerous as might be expected from the length of time through which they were distributed. Enough, however, was done in the deeper parts of the lake to show fully the composition of the bottom, and to indicate clearly the nature of the deep-water fauna of the lake.

The following list will show the localities at which dredgings were made, the depth, and the composition of the bottom:

Simmons's Harbor, on the north shore of the lake, about twelve and one-half miles north-northwest of Otter Island, August 9, 13 to 15 fathoms, bottom of fine sand with scattered tufts of a small alga of the genus Cladophora.

Five miles off Simmons's Harbor, August 11, 60 fathoms, soft bluish clay.

Among the Slate Islands, August 14, while at anchor, two hauls: First, 12 to 14 fathoms, sand with a little fine mud. Second, from the other end of the steamer, 6 to 8 fathoms, sand, gravel, and small stones, with some mud.

On a line from the Slate Islands toward Stannard Rock, August 15, four hauls were made as follows: First, about eighteen miles south of the western end of the islands, 105 fathoms, soft clay. Second, about thirty-five miles from the islands, 169 fathoms, the deepest point yet found in the lake, very soft, light-drab clay, with small pieces of rotten wood. Third, about forty miles from the islands, 116 fathoms, bottom same as in the last haul. Fourth, about fifty-seven miles from the islands, 159 fathoms, very soft clay.

On a line southeast from Passage Island, off the east end of Ile Royale, August 18, hauls were made at five points: First, about six miles out, 47 fathoms, soft reddish clay and sand. Second, about fifteen miles from Passage Island, 129 fathoms, soft clay. Third, about twenty-nine miles from the island, 127 fathoms, bottom same as last haul. Fourth, about forty-three miles from the island, 134 fathoms, bottom as in the last two hauls. Fifth, about fourteen miles north of Keweenaw Point, 82 fathoms, two hauls, reddish clayey mud and sand.

North of Copper Harbor, August 22, dredgings were made at three different points: First, seventeen miles off, 148 fathoms, soft clay. Second, nearer the shore, 62 fathoms, soft reddish mud and sand. Third, within a quarter of a mile of the shore, 17 fathoms, sand.

Off fifty miles on a course northeast by east, one-half north of Copper Harbor, August 24, 116 fathoms, soft clay.

In Neepigon Bay, due north of St. Ignace station, and half a mile from the shore of St. Ignace Island, August 28, 32 fathoms, very soft clayey mud.

In the cove at the eastern end of St. Ignace Island, near St. Ignace station, August 29, 4 to 6 fathoms, sand with some mud, bits of wood, &c.

About three miles south of the same cove, August 29, 73 fathoms, soft clayey mud.

In a small harbor on the south side of St. Ignace Island, between the main island and a smaller one, and due south of St. Ignace station, September 4, two hauls, 8 and 10 to 13 fathoms, a little sand and mud brought up with great quantities of the same species of alga found at Simmons's Harbor, and which, according to Professor Eaton, who has kindly examined it for me, is a small densely tufted species of *Cladophora*, possibly *C. glamerata* Linn., a most variable species, but the specimens do not well correspond with authentic ones from Germany. This alga was brought up in immense quantities, the dredge being full at each haul.

On a line between Michipicoten Island and Copper Harbor, and about thirty-seven miles from the island, September 7, 147 fathoms, soft clay.

From this list it is readily seen that, in all the deeper parts of the lake, the bottom is covered with a uniform deposit of clay or clayey mud. All the soundings made by the survey show the same thing, the specimens of the bottom brought up from deep water by the lead being everywhere of the same character, varying only in color and somewhat in the amount of sand mixed with the clay. The color was not uniform, even in the same dredge-full, drab and bluish masses of the clay being frequently mixed with brown or reddish lumps. In deep water, drab and bluish were the prevailing tints, however. Water was taken from the bottom at many points, and was everywhere perfectly fresh. That from 169 fathoms gave no precipitate with nitrate of silver. The temperature, everywhere below 30 or 40 fathoms, was very uniform, varying only slightly from 39°, while at surface, during the season at which the dredging was carried on, it varied from 50° to 55°.

The fauna of the lake-bottom corresponds with these physical conditions. In the shallow waters along the shores, the fauna varies with the varying character of the bottom, while below 30 to 40 fathoms, where the deep-water fauna properly begins, the same species seem to be everywhere nearly uniformly distributed down to the deepest points. The soft clayey bottom is, however, very unfavorable to most forms of animal life, and, as we might expect, the fauna of this region is very meager. Except among the worms, it seems to have scarcely any species peculiar to it, and is characterized rather by the absence of many of the shallow-water species than by forms peculiar to itself.

In the following notes upon the species obtained, I am indebted to Professor Verrill, for the entire account of the worms.

FISHES.

Cottus Franklini **Agassiz.**—Several specimens were taken, in 8 to 13 fathoms, among *Cladophora*, &c., on the south side of St. Ignace.

INSECTS.

Chironomus, larvæ and pupæ.—Species of this, or of closely allied genera of small, two-winged flies, were found in nearly all the dredgings. Several quite large whitish forms, both larvæ and pupæ, were common in all the dredgings down to 32 fathoms. A minute, entirely blood-red species was found in 6 to 8 fathoms among the Slate Islands, and in 8 to 13 fathoms on the south side of St. Ignace. A slender, semi-translucent form was found in many of the dredgings from shallow water down to 147 fathoms.

An unknown dipterous larva, 4 to 6 fathoms, cove at the eastern end of St. Ignace.

Ephemeridæ.—The larva of a single species, 32 fathoms, Neepigon Bay.

Phryganeidæ.—Two species, 8 to 13 fathoms, south side of St. Ignace.

Hydrachna sp.—Taken in 4 to 6 fathoms in the cove at the eastern end of St. Ignace.

CRUSTACEA.

PODOPHTHALMIA.

Mysis relicta Lovén.—About ten years ago the Danish naturalist Lovén[*] described a species of *Mysis* under this name from Lakes Winer and Wetter, in Sweden. It was found in company with *Pontoporeia affinis* Lindström, *Pallasia cancelloides* (Gerstfeldt sp.), *Gammaracanthus loricatus* Bate and *Idotæa entomon*, the last two being known also as marine species. Lovén describes the species of *Mysis* as closely allied to the *M. occulata* Fabricius, a marine species found on both sides of the Atlantic, and he regards its occurrence, and that of the *Pontoporeia*, as evidence that the lakes where it is found were formerly filled with salt water, that they had been cut off from the sea by the elevation of the Scandinavian peninsula, and that the differences between these species of the lakes and their allies of the neighboring ocean have been brought about by the gradual changes in the habitats of the lake species. I have compared specimens of the *Mysis* and *Pontoporeia* from Lake Wetter with those from Lake Superior, and I am unable to find any characters by which to distinguish the European from the American forms. G. O. Sars, in his great work on the fresh-water crustacea of Norway, describes this same species of *Mysis* from Lake Mjösen, where he found it in from 3 and 6 to 200 fathoms.[†] Sars, however, regards it as only a variety of the marine *Mysis occulata.*

In Lake Superior, the *Mysis*, was found in a large number of the dredgings. It was brought up with sand and mud from 12 to 14 fathoms among the Slate Islands, from 4 to 6 fathoms in the cove at the eastern end of St. Ignace, from 8 and 13 fathoms with *Cladophora*, &c., on the south side of St. Ignace, and from deep water, in a large proportion of the hauls, from 73 to 148 fathoms.

AMPHIPODA.

Pontoporeia affinis Lindström.—What has been said in regard to the identity of the *Mysis* from Lake Superior and the Scandinavian lakes applies equally well to this species. I can find no good differences between the Lake Wetter and the American specimens. Lovén, in the paper referred to, regards the European form as closely allied to the *Pontoporeia femorata* Kroyer from the Greenland seas; while Sars, who found it in the small lakes near Christiania, has regarded it as a variety of that species. In Lake Superior it was abundant, and occurred at every dredging, from the shallowest to the deepest.

Since the above notices of the species of *Mysis* and *Pontoporeia* were written I have received through the courtesy of Dr. Stimpson, of the Chicago Academy of Sciences, the *Mysis*, three species of Amphipoda, and the *Pisidium* dredged by him in Lake Michigan in the summer of 1870, and of which a short notice was published by Dr. Stimpson in the American Naturalist for September of that year. On comparison I find the *Mysis* and one of the species of Amphipoda from Lake Michigan of the same species as the *Mysis* and *Pontoporeia* from Lake Superior, while the other species of Amphipoda are quite different from the *Gammarus* and *Crangonyx* described beyond. Dr. Stimpson, however, regards the forms from Lake Michigan as new species, but I am not aware that he has compared them with specimens from the European lakes.

Crangonyx gracilis Smith, sp. nov.—Eyes slightly elongated, black, composed of few facets. Antennulæ slender, slightly more than half as long as the body; secondary flagellum but little longer than the basal segment of the primary. Antennæ much shorter than the antennulæ; the flagellum and peduncle of about equal length, the peduncle being a little longer than the peduncle of the antennulæ. Gnathipoda subequal in both sexes, the second pair being only slightly larger than the first; propodus in the first pair quadrate, the palmary margin transverse, nearly straight, and armed with slender spines, of which one or two at the prominent posterior angle are much larger than the others; propodus in the second pair like those of the first, but a little more elongated, and the palmary margin slightly oblique. Third, fourth, and fifth pairs of pereiopoda equal in length, and the margins of their basa spinulose. Ultimate pleopoda reaching to the tips of the penultimate; the outer ramus nearly twice as long as the peduncle, and armed with slender spines; the inner ramus very minute, shorter than the width of the outer. Telson scarcely as long as the bases of the ultimate pleopoda, slightly broader than long, and the posterior margin with a triangular emargination, either side of which the extremity is truncate and armed with several spines.

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[*] Om nagra i Vettern och Venern fauna Crustaceer Översight af Kongl. Vetenskaps—Akademiens Förhandlingar. Stockholm, xviii, 1861, p. 285.

[†] Zoölogical Record for 1867, p. 617.

The incubatory lamellæ of the female are very large, projecting much beyond the coxæ of the anterior legs, as in *C. recurvatus* Grube, (Archiv für Naturgeschichte, xxxii, p. 410, pl. 10, fig. 1,) which our species much resembles in the form of the antennulæ, antennæ, gnathepoda, &c., while it differs much in the ultimate pleopoda and in the form of the telson. Length 6 to 7^{mm}.

Among *Cladophora*, in 8 to 13 fathoms on the south side of St. Ignace.

Gammarus lacustris Smith, sp. nov.—Eyes slightly elongated, black. Antennulæ not quite half as long as the body, and furnished with a few short hairs; first and second segments of the peduncle equal in length, third much shorter; flagellum twice as long as the peduncle. Antennæ a little shorter than the antennulæ; ultimate and penultimate segments of the peduncle equal in length, the basal segments short; flagellum considerably shorter than the peduncle. Gnathipoda about equal in size; propodus in the first pair elongated and much narrowed toward the articulation of the propodus, palmary margin slightly concave, continuous with the posterior margin, and furnished, like it, with several stout spines and numerous long hairs; dactylus slightly curved and fully half as long as the propodus; propodus in the second pair a little broader, the lateral margins nearly parallel, the palmary margin somewhat oblique, slightly concave, and furnished with a thin raised margin and several stout spines, the posterior margin without spines, but furnished with numerous fascicles of hairs. Pleon rounded above, the fourth and fifth segments each with three fascicles of two or three small spines. Third, fourth, and fifth pairs of pereiopoda subequal, their basa narrow and the margins furnished with few minute spines. Rami of the posterior pair of pleopoda very slender, the edges furnished with long hairs and a few spines, inner only a little shorter than the outer. Length, 15 to 20^{mm}.

Color in life, uniform, obscure dark-brownish green, without spots or markings of any kind.

Common in company with the last species in 8 to 13 fathoms; also, at Simmons's Harbor, in 13 to 15 fathoms; and among the Slate Islands in 4 to 6 and 12 to 14 fathoms.

ISOPODA.

Asellus tenax Smith, sp. nov.—Head broad, with a large rounded sinus in the margin on each side opposite the eye, back of which the margin projects in a rounded lobe, so that the head is not narrower, posteriorly, than the anterior margin of the first segment of the pereion. Eyes small, prominent, and separated from the margin of the head by more than their diameters. Antennulæ much shorter than the peduncles of the antennæ. Antennæ half as long as the body; the flagellum longer than the peduncle. Propodus in the first pair of gnathipoda narrow and elongated, but considerably stouter in the male than in the female; dactylus more than half as long as the propodus and its palmary edge armed with acute spines, of which the distal ones are larger. The succeeding pairs of legs all similar, the carpal and propodal segments subequal in length and armed with short spines along the posterior edges; the dactyli short, armed with a few spines on the posterior margin and bi-unguiculate at tip. Pleon narrowed posteriorly, and the extremity obtusely rounded. Posterior pleopoda slender, the outer ramus only half as long as the inner. Length, 8 to 13^{mm}.

Color above dark fuscous, spotted and mottled with yellowish.

Common with the last two species, among the *Cladophora*, in 8 to 13 fathoms on the south side of St. Ignace, also in 4 to 6 fathoms at the eastern end of St. Ignace, and in 6 to 8 fathoms among the Slate Islands.

ENTOMOSTRACA.

Numerous species of entomostraca were collected at different points, but this group of crustacea has been so entirely neglected in this country that their investigation will require much careful study, and I can notice them now only in a very general way.

Of the Cladocera, species of *Daphnia* and *Lynceus* were abundant among the *Cladophora* on the south side of St. Ignace. A species of *Daphnia*, different from the one just mentioned, and a species of a closely allied genus, were taken by towing the dredge a short distance below the surface. These species were also once or twice brought up in dredging in deep water, perhaps taken in the dredge on its way up.

Ostracoda of several genera and quite a number of species were collected, some of them being found in nearly every dredging, even down to 159 fathoms.

Of Copepoda, species were obtained at nearly every haul, some of them the same species as those obtained near the surface, but many of them different, and undoubtedly from near the bottom. They were almost always abundant in the dredgings in which *Mysis* occurred, undoubtedly furnishing most of its food.

ANNELIDA, (Worms.)

LUMBRICIDÆ, (Earth-worms, &c.)

Lumbricus lacustris Verrill, sp. nov.—About 1.5 inches long, .04 in diameter. Body round; distinctly annulated. Head short, conical, obtusely pointed. Setæ spine-like, strongly curved, acute; arranged two by two, those of each pair close together. Color reddish brown.

South side of St. Ignace, among Cladophora, 8 to 13 fathoms, abundant.

Sænuris abyssicola Verrill, sp. nov.—Worm slender, attenuated posteriorly, about .30 inch long, .03 in diameter anteriorly. Body composed of about 28 segments; those of the posterior half elongated; those of the anterior half shorter, separated by slight constrictions. Cephalic lobe short, subconical, rounded in front. Mouth large, semicircular. Intestine slender, moniliform, containing sand. Anus terminal, with three or four slight lobes. Setæ in four fan-shaped fascicles on each segment, commencing at second segment behind the mouth. The two ventral fascicles are separated by a space equal to about twice the length of the setæ, of which there are five or six in each fascicle; the setæ are simple, acute, slightly curved, equal to about one-sixth the diameter of the body. The lateral fascicles contain three to five somewhat shorter and straighter simple setæ. One specimen appeared to have four minute ocelli upon the upper side of the head.

Off Copper Harbor, 17 fathoms, sand; off Simmons's Harbor, 60 fathoms; and on the line from the Slate Islands toward Stannard Rock, fourth haul, 159 fathoms.

Sænuris limicola Verrill, sp. nov.—Worm more slender than the preceding, attenuated posteriorly, composed of about 44 segments. Length about .33 of an inch, diameter .02. Cephalic lobe blunt, conical. Setæ in four fascicles upon each segment, six to eight in each fascicle anteriorly, four or five posteriorly. The setæ in all the fascicles are relatively long, slender, curved, and acute. Two tortuous, red blood-vessels pass along the intestine, forming a loop at each segment. Intestine moniliform.

On the line between the Slate Islands and Stannard Rock, fourth haul, 159 fathoms.

Chirodrillus, gen. nov.—Allied to *Sænuris*, but with six fan-shaped fascicles of setæ upon each segment; two of which are ventral, two lateral, and two sub-dorsal. Setæ in the ventral and lateral fascicles five to nine, simple, acute, slender, often curved like an italic *f*; those of the upper fascicles stouter and less curved, three to six in each fascicle. Intestine wide, somewhat moniliform. Anus terminal, large.

Chirodrillus larviformis Verrill, sp. nov.—Body rather short and not very slender cylindrical, obtuse at both ends, distinctly annulated, composed of about 38 rings. Length about .30 of an inch; diameter .05. Cephalic lobe short, conical, obtuse, mouth large, semicircular beneath. Ventral fascicles of setæ near together, with about five setæ, which are rather short, simple, acute, little curved; lateral fascicles anteriorly with five or six setæ of similar form and size; upper ones similar. When preserved in alcohol the body is usually curved ventrally or in a simple coil. Color, when living, translucent, whitish; intestine slightly greenish.

Off Copper Harbor, 17 fathoms, sand; off Simmons's Harbor, 60 fathoms, clayey mud.

Chirodrillus abyssorum Verrill, sp. nov.—Subcylindrical, thicker anteriorly, distinctly annulated, composed of about 42 segments. Length .25 of an inch; diameter about .02. Cephalic lobe short, conical, obtuse, mouth large, semicircular. Ventral fascicles with eight or nine setæ anteriorly, five or six posteriorly. The setæ are long, slender, acute, strongly curved, those on the inferior side of the fascicles nearly twice as long as those of the upper side; setæ of the lateral fascicles five or six, slender, nearly as long as those of the ventral ones, and similar in form; sub-dorsal fascicles with four or five shorter, stouter, and straighter acute setæ.

Six miles southeast of Passage Island, 47 fathoms; on line from the Slate Islands toward Stannard Rock, fourth haul, 159 fathoms.

Tubifex profundicola Verrill, sp. nov.—A rather stout species for the genus, about 1 to 1.5 inches long, .05 in diameter anteriorly, more slender posteriorly (.02 in diameter.) Cephalic lobe short, conical; one specimen apparently had two minute ocelli. Mouth large, semicircular. Intestine moniliform, with two simple red blood-vessels running along its whole length and uniting at the constrictions. In the first five or six segments there are slender vessels of nearly uniform size, which form lateral loops in each segment. Anus terminal, wide, with about ten small lobes. Setæ in four fascicles upon each segment. Those of the lateral fascicles three, anteriorly often but two, short, slightly curved, mostly with minute, forked, and hooked tips; those of the ventral series in fascicles of four to six, three or four times longer than the upper ones, considerably bent, the ends minutely hooked and forked.

Neepigon Bay, 32 fathoms.

BDELLODEA, (Leeches.)

Nephelis fervida Verrill, sp. nov.—Leech two or three inches long, .20 to .30 wide, elongated and slender in full extension, very little depressed, most so posteriorly; often round and tapering anteriorly. Mouth large, nearly circular, subterminal, the upper lip, in contraction, short and rounded, corrugated within the œsophagus with three conspicuous folds; eyes eight, blackish, conspicuous, two pairs, a little apart, on the first ring of the head; two pairs, wider apart and farther back, on the third ring. Color bright brick, red when living. In 8 to 13 fathoms, south side of St. Ignace.

A small specimen, probably the young of this species, taken in 13 to 15 fathoms, in Simmons's Harbor, was translucent, tinged with flesh-color, with a dark brown intestinal line posteriorly.

Nephelis lateralis Verrill, (*Hirudo lateralis* Say.)—A small specimen, about 1 inch in length, of an obscure liver-brown color, was taken in 6 to 8 fathoms, among the Slate Islands, which probably belongs to this species.

Ichthyobdella punctata Verrill, sp. nov.—Body, in extension slender; in the preserved specimen, about .5 of an inch long, .06 in greatest diameter, rounded, thickest posteriorly, tapering anteriorly to the anterior sucker, which is broad and thin, subcircular, about three times as wide as the neck where it is attached; ocelli four, on the upper side of the anterior sucker, the two larger, black ones, in front, and two minute ones wider apart and farther back. Posterior sucker large, rounded, or oval. Color translucent greenish, with minute black specks, arranged in transverse bands.

Among the Slate Islands, 6 to 8 fathoms.

DENDROCŒLA, (Flat-worms.)

Procotyla fluviatilis Leidy.—Numerous specimens, apparently of this species, were obtained in 8 to 13 fathoms, on the south side of St. Ignace. They were, when living, dirty white, mottled with brown.

In addition to the preceding species of worms, a few were obtained which have not yet been fully determined.

MOLLUSCA.

GASTERIPODA.

Limnæa.—A species allied to *L. disidiosa* Say, was abundant among *Cladophora* in 8 to 13 fathoms, on the south side of St. Ignace Island.

Physa heterostropha Say. In the cove at the eastern end of St. Ignace, in 4 to 6 fathoms, and young specimens in 8 to 13 fathoms, at the locality with the *Limnæa* just mentioned.

Physa vinosa Gould.—A very young specimen, apparently of this species, in 6 to 8 fathoms, among the Slate Islands.

Planorbis parvus Say.—Common in 8 to 13 fathoms, on the south side of St. Ignace.

Valvata sincera Say, sp.—Abundant with the last species, in 8 to 13 fathoms, and also in 4 to 6 fathoms, in the cove at the eastern end of the same island.

LAMELLIBRANCHIATA.

Sphærium, sp. nov.? Among the Slate Islands, in 6 to 8 fathoms.

A single young specimen of another species of *Sphærium* was found, in 8 to 13 fathoms, on the south side of St. Ignace.

Pisidium Virginicum Bourguignat. On the south side of St. Ignace, 8 to 13 fathoms.

Pisidium abditum Haldeman. With the last species, in 8 to 13 fathoms, and also in 4 to 6 fathoms, in the cove at the eastern end of the same island.

Pisidium compressum Prime. In the cove at the eastern end of St. Ignace, 4 to 6 fathoms.

Pisidium, sp. nov. A small, semitranslucent species, the same as found by Dr. Stimpson in Lake Michigan, was brought up at nearly every dredging. It was common in the cove at the eastern end of St. Ignace, on sandy and muddy bottom, in 4 to 6 fathoms, and abundant among *Cladophora*, in 8 to 13 fathoms, on the south side of that island; among the Slate Islands, in 6 to 8 and 12 to 14 fathoms; at 13 to 15 fathoms on a sandy bottom in Simmons's Harbor; near Copper Harbor, in 17 fathoms, clear sand; in 32 fathoms, very soft clayey mud, in Neepigon Bay; off Copper Harbor, in 62 fathoms, and north of Keweenaw Point, in 82 fathoms, soft reddish clayey mud and sand; and in all the deep dredgings down to 159 fathoms. Below 100 fathoms, however, it was never abundant.

RADIATA.

Hydra carnea Agassiz. A beautiful *Hydra*, agreeing with Ayer's description of this species, was very abundant at the eastern end of St. Ignace, upon rocks along the shore and near the surface, frequently completely covering quite large surfaces, where they were protected from the direct sunlight, and was also brought up in many of the dredgings from 8 to 148 fathoms. In 32 fathoms, Neepigon Bay, and [illegible] off Simmons's Harbor, it was brought up in abundance from a [illegible] the deep dredgings, it frequently came up near the bottom of [illegible] and was evidently not caught while the dredge was near the [illegible]

A noticeable feature of this imperfect faunal list is the [illegible] the *Lumbricidæ*, or the family of earth-worms, which is represented [illegible] species, all but one of them being inhabitants of deep water.

As regards the geographical distribution of species, the most [illegible] is, undoubtedly, the identity of the species of *Mysis* and *Pontop*[illegible] lakes of Northern Europe.

This fact does not accord with Agassiz's[*] conclusions from [illegible] fishes of Lake Superior, all of which he regarded as distinct from [illegible] yet it is paralleled in the case of some fresh-water mollusca, while [illegible] trial animals, and especially the plants, both land and fresh water, are [illegible] northern parts of both countries. Whether these forms are to [illegible] species, or only varieties of their marine allies, is a question on [illegible] pretend to offer an opinion, as I have had no opportunity for [illegible] specimens from the North Atlantic. Whether or not they have [illegible] ancient marine species left in the lake basins by the recession of [illegible] case, in the present state of our knowledge, a difficult question [illegible] the investigation of the deep-water faunæ of the lower lakes, and [illegible] Champlain, which we know to have been connected with the ocean [illegible] ical period, and hence to have a derivative fauna, would throw [illegible] the other deep-water forms, there is no evidence whatever of derivat[illegible] species. The insect larvæ, all the worms, the *Pisidium*, and the *Hy*[illegible] fresh-water forms, while the Ostracoda and Copepoda, as groups, [illegible] both fresh and salt water.

The main facts of the bathymetrical distribution of the species are [illegible] following table:

Names.	Depths in [illegible]				
	4–8	10–17	30–50	[illegible]	[illegible]
Cottus Franklini	x	x	......	....	....
Chironomus larvæ	x	x	x	x	x
Ephemeridæ larvæ	x	x	x	....	....
Phryganeidæ larvæ	x	x	......	....	
Hydrachna	x	......	......	....	....
Mysis relicta	x	x	x	x	x
Pontoporeia affinis	x	x	x	x	x
Crangonyx gracilis	x	x	......	....	....
Gammarus lacustris	x	x	......	....	....
Asellus tenax	x	x	......	....	....
Cladocera	x	x	(?)		
Ostracoda	x	x	x	x	x
Copepoda	x	x	x	x	x
Lumbricus lacustris	x	x	......	....	
Sænuris abyssicola	......	x	......	x	....
Sænuris limicola	......	......	......	....	....
Chirodrillus larviformis	......	x	......	x	....
Chirodrillus abyssorum	......	......	x	....	....
Tubifex profundicola	......	......	x	....	....
Nephelis fervida	x	x	......	....	....
Nephelis lateralis	x	......	......	....	....
Ichthyobdella punctata	x	......	......	....	
Procotyla fluviatilis	x	x	......	....	
Limnæa	x	x	......	....	
Physa	x	......	......	....	
Planorbis parvus	x	x	......	....	....
Valvata sincera	x	x	......	....	....
Sphærium	x	x	......	....	....
Pisidium virginicum	x	x	......	....	....
Pisidium abditum	x	x	......	....	....
Pisidium compressum	x	......	......	....	
Pisidium, sp. nov	x	x	x	x	x
Hydra carnea	x	x	x	x	x

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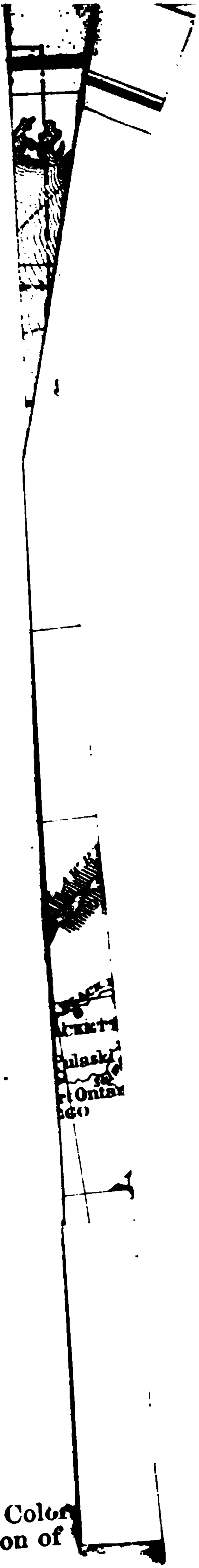
[*] Lake Superior, its physical character, vegetation, and animals, compared with [illegible] similar regions.



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APPENDIX Z.

OFFICE OF THE GEOLOGICAL EXPLORATION OF THE FORTIETH PARALLEL.

NEW HAVEN, CONNECTICUT, *February* 14, 1871.

SIR: Complying with your instructions in your letter of February 10, to furnish you with a brief, succint account of all my operations under your orders, in connection with the geological exploration of the fortieth parallel, I have the honor to submit the following memoranda:

Receiving your letter, assigning me to the charge of this work, and defining my duties, upon the 22d of March, 1867, I began at once the organization of a corps, and the preparation of the materials for an early campaign, and the 5th of June I landed in San Francisco with my party, and on the 1st of July I marched across the Sierra Nevada and took the field in Western Nevada.

My corps aids consisted of three geological, three topographical, one botanical, one zoological, and one photographic assistants.

The general plan of operations, as defined by yourself, was to execute a geological and topographical exploration of the country bordering upon the Central and Union Pacific Railroads, expanding as far to the north and south of the fortieth parallel as practicable.

During the summer of 1867 we covered a block of territory extending westward from the boundary of California, longitude 120° west, as far east as the second Humboldt Range; the southern boundary of the work being latitude 39° 30′ west, the northern boundary latitude 41° north. This block may be seen at a glance upon the portion of the United States Engineer's map herewith inclosed, upon which will be found, colored, the limits of this season's work.

In the prosecution of this campaign the party suffered terribly from miasmatic fevers, which decimated that whole region of the Great Basin. At one time we had, out of fifty, but three available men. In early autumn, however, the party recovered their health, and by a tremendous effort completed the proposed area for the year by remaining in the field until the middle of December, the last parties coming into our winter quarters at Virginia City, through two feet of snow, on the day before Christmas.

Upon reaching Virginia City the topographical corps immediately began the work of plotting their field-notes, and the geological assistants commenced a detailed study of the great silver region of the Washoe. By the middle of April we had completed the investigations of the silver district, and the season being propitious, we took the field again, marched eastward to where the work had been left off the year before, resumed it, and working in three divisions carried it forward as far as the western limit of the Great Salt Lake Desert. The block of this year is also distinctly shown upon the inclosed sketch. Beside the regular work, a geological exploration was made of the Toyabe silver-bearing mountain range, including the Reese River and Belmont mining districts.

On the completion of these districts, I sent Mr. James Hague, the first geological assistant, to the White Pine district, then a new silver locality. After the close of his examination there, he went, by my orders, to Colorado, and spent the rest of the summer in a detailed examination of the various gold and silver deposits of that Territory.

In the middle of October we reached Salt Lake City, disposed of our animals for the winter, and came to Washington to pursue our office work, reaching there October 20, 1868.

About the 1st of May, 1869, we again took the field: recommenced work in two divisions at the north and south ends of the Salt Lake Desert, and surveyed the entire country eastward as far as the Green River divide, our eastern line terminating about thirty miles west of Green River; the belt, as before, measured one hundred miles from north to south.

On the completion of this work, in September, 1869, I sent the greater part of the men back to the Washington office, and, with a small field party, marched back over our line of survey, verifying certain observations and filling missing links in the system of triangulation: also bringing up to date the study of the mining districts over the whole line.

The summer of 1869 was spent by Mr. James Hague chiefly in Colorado, the latter two months of the autumn were, however, given to Nevada.

On the 5th of August, 1870, came your unexpected instructions to take the field at once. This was immediately complied with, the party arriving at San Francisco on the 12th of that month. The short campaign, which lasted from the 1st of August to the middle of November, was wholly devoted to the study of the sources of the lava-flows which have poured eastward from the axial line of the Sierra Nevada and the Cascade Ranges into the Great Basin. The object of this investigation was something more than a scientifically satisfactory study of the laws of volcanic out-flow. An investigation of those parts of the western mountains which are covered with perpetual snow gives the key to the present and past climatic conditions, and it is there alone that we may hope to discover whether the present desert conditions of the Great Basin and interior are *in statu quo*, or are likely to be modified, favorably or unfavorably, by climatic oscillations now in process.

This is very briefly the outline of the four campaigns and of the field we have covered.

I will now state as briefly the methods of work, the character of the problems investigated, and what I consider to be the chief results.

The foundation of our explorations has been a continuous system of triangulation, carried from mountain-top to mountain-top, over the whole extent of our work, by theodolite observations upon stone monuments. These triangles have been located geographically, and their distances computed from a base and check-base, and a system of astronomical stations. Within the primary triangles a large number of secondary triangles were located, by a large theodolite, from the primary points, and from these, working always inwardly, a thorough system of minor triangles have been measured with the gradienter, and the topography filled in by compass and gradienter, basing the system upon 300-foot grade-curves, located approximately by the barometer. In connection with this, the altitude of all prominent mountain-peaks and localities upon the plains have been determined.

In the department of geology careful and actual sections have been made over the whole area; the superposition of the immense variety of irruptive rocks has been, in almost all cases, accurately determined: the dynamical questions, such as the build of mountains, the upheaval of chains, and the formation of mining districts and of mineral-bearing lodes, have received our careful attention.

An extensive series of observations was also made upon the present climatic conditions of the Great Basin, as regards its isothermal lines, annual and monthly averages of temperature, relative evaporation, and the outlines of storms and rainfall.

In the department of botany a very large collection has been made, resulting in the discovery of somewhat over a hundred species of plants new to science, in a complete knowledge of the distribution of timber, and the leading families of the Desert flora.

In zoology, the collection has been equally careful, and the results, according to Professor S. F. Baird, in whose hands they now are, is of interest and value.

The work embraces a very complete scientific examination of a section of country which traverses, from west to east, nearly the entire Cordillera system. The rocks at our eastern terminus are already those of the Atlantic formations, and are being extensively studied by a number of geologists.

In the department of mining industry our labors have been completely worked up, and the volume and accompanying atlas, embracing the elaborated results of our three years' study, is already printed, and being bound at the congressional establishment. Also, the topographical maps of the fortieth parallel belt are plotted on a scale of two miles to the inch, and have been photographically reduced to a scale of four miles to the inch, resulting in three maps, about 30 by 40 inches each. These maps, assembled in grade-curves, are now being drawn in *hachure*, preparatory to lithographing them upon stone.

The volume of botany is completed, transmitted, and in process of printing. That of geology is also completed, and has been transmitted, and awaits the action of the Congressional Printer, who is unable to keep up with our rate of furnishing material.

To complete the series, I propose two more volumes: one, descriptive geology, and one embodying general results. That on descriptive is now in active preparation, and the geological maps accompanying it are already in the hands of the engraver.

These volumes, making thus far four, will be brought out as quickly as the printer can execute them. For the first, or general volume, I am unable at present to fix a definite time; its scope being somewhat unique, forbids a definite estimate.

When finished, the series is designed to embody, first, a ground-work topographical map, upon which shall appear all the features of the country surveyed; second, a series of geological maps, illustrating the formations of rocks, soils, alkaline deposits, and the distribution of arable land; third, a general report, which, in a synthetical manner, shall describe the history of the formations of that portion of the Cordillera, its original deposition in the primeval ocean, the evolution of continental features and mountains, the minute lithological structure of each family of rocks, and chapters upon the volcanic and glacial ages; and an attempt to explain the present physical conditions, and an account of a considerable climatic change now going on.

As appendices to this, the second, third, fourth, and fifth volumes will treat of technical geology, zoology, and mining industry.

Of the manner in which this immensely difficult plan is being executed, I can only say that we are bestowing untiring labor, and making use of all the most modern appliances of science.

I have the honor to be, very respectfully, your obedient servant,

CLARENCE KING,
Geologist in Charge.

Brigadier General A. A. HUMPHREYS,
Commanding Corps of Engineers, Washington, D. C.

Z 1.

GEOLOGICAL EXPLORATION OF THE FORTIETH PARALLEL.

Camp in Eastern Uintah Mountains, October 3, 1871.

GENERAL: I have the honor to report that, on the 26th of August, my Bridger division, under Mr. Emmons, left our camp at Fort Bridger, and entered the Uintah Range near the head of Black's Fork of the Green River, intending to work thence eastward to the Green River Cañon. From that date to yesterday extensive fires have raged throughout the entire Rocky Mountains, filling the air with such volumes of smoke as to altogether stop topographical work. The party have occupied themselves altogether with geological work, and, in consequence, while this branch is in an advanced stage, the party, as a whole, will be kept in the field a little over a month more than I had estimated.

On August 27, with my Cheyenne division, I marched from Fort Sanders into the North Park and the Elk Head Mountains. We there met the same unfortunate experience as regards smoke. And there, too, we were driven back on geology as the only possible labor. September 25 I left that division, and came to this, because the complicated work around Green River demanded my presence.

All day before yesterday a heavy snow-storm prevailed over the whole mountains, and to-day, for the first time, the air is clear, and as no smoke arises from the timber-lands, I conclude we shall have favorable weather.

I start to-morrow for the great cañon of the Green River, and have no doubt the eastern party also renew their triangulations to-day. Our geological results accumulate richer and richer. I can truthfully say that the success there is brilliant. We shall finish up our surveying, but I cannot hope to finish before December 1. As we near completion, I shall reduce the party as rapidly as practicable, to cut down expenses.

Very respectfully, your obedient servant,

CLARENCE KING,
Geologist in Charge.

Brigadier General A. A. HUMPHREYS,
Chief of Engineers, U. S. Army, Washington, D. C.

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